RADIO'S LIVEST MAGAZINE

A GERNSBACK PUBLICATION

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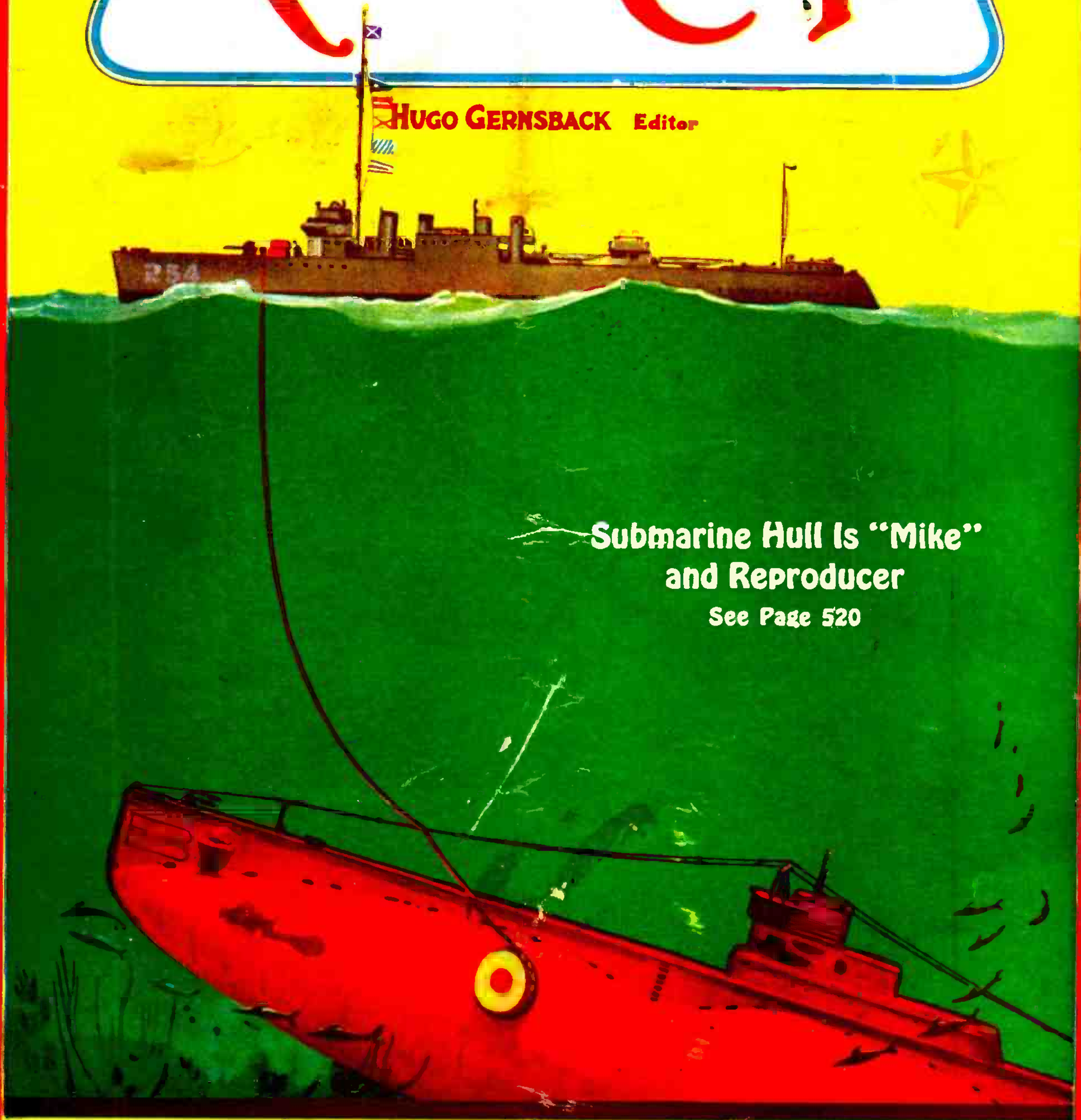
1932

Radio-Craft

HUGO GERNSBACK Editor



Submarine Hull Is "Mike" and Reproducer

See Page 520

Servicing Short-Cuts — The "Screen-Grid 6" Automotive Radio Set
The Positive-Grid Tube — Electrolytic Variable Condensers

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Radio-Craft

FOR THE SERVICE MAN - DEALER - RADIOTRICIAN

HUGO GERNSBACK, Editor-in-Chief

R. D. WASHBURNE
Technical Editor

LOUIS MARTIN
Associate Editor

VOLUME III
NUMBER 9

MARCH
1932

Contents of This Issue

In Forthcoming Issues

TUBE DEVELOPMENTS. Interesting information on several new tube designs of heretofore unavailable type. Operating characteristics and design data are given.

DESIGN AND CONSTRUCTION OF I.F. TRANSFORMERS. A discussion of the numerous factors which enter into the design of intermediate frequency transformers of all types.

A COMPACT SET TESTER. Constructional details of a simple and effective set tester which meets the demand for an instrument of light weight and small-space design.

SOME FUNDAMENTAL RADIO EXPERIMENTS. A series of astounding experiments, based on sound theory, which may pave the way to entirely new radio receiver design.

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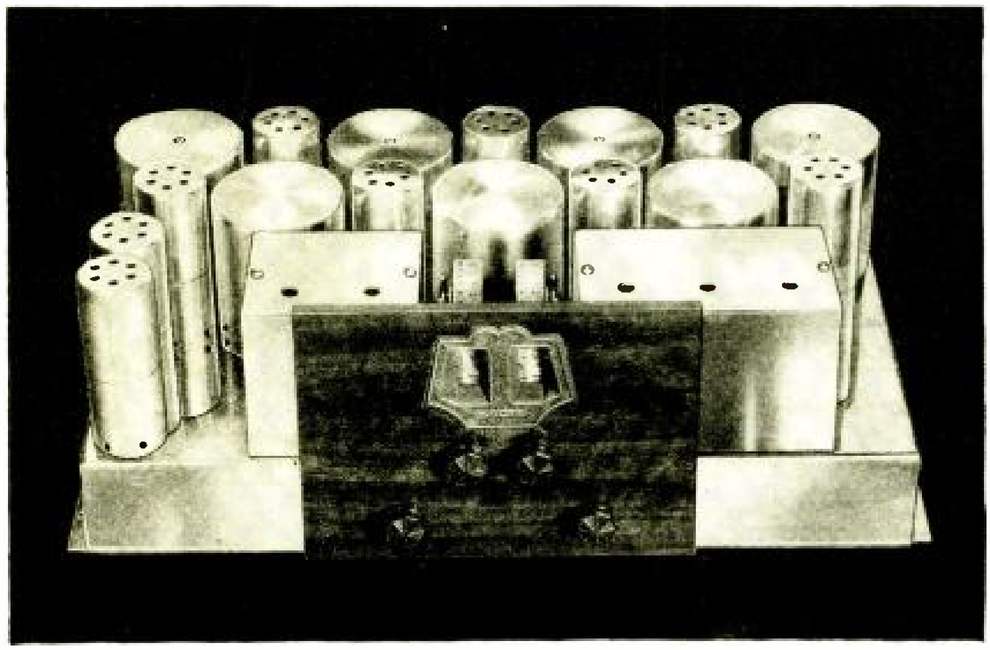

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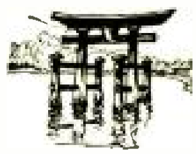

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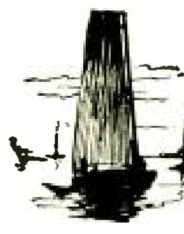

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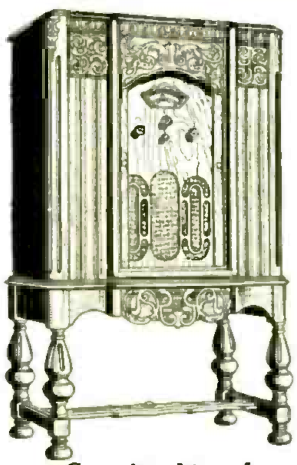

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FOR THE
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"Takes the Resistance Out of Radio"
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HUGO GERNSBACK
Editor

UNEXPLORED RADIO

By HUGO GERNSBACK

THERE are some people in the radio profession who feel that we know quite a good deal about our diverse radio instrumentalities, that we have explored practically everything, and that radio is now a pretty well "settled" art.

Nothing could be more erroneous than this. As a matter of fact, everything in the whole radio art is so new, that we may safely say that not even the surface has been scratched. We may also safely predict that radio, as we shall have it, say fifty years hence, will be something totally different from what we have today. It was thus with the electrical art. When it started, batteries were the only source of power known; then, later on, everyone used D.C. generators; while today, we are all coming to alternating current.

With radio, the parallel is far greater because, as yet, we have not even found the best instrumentalities for it. Our tubes are still crude affairs—marvelous as they are. If you compare present-day tubes with those of 1914, and then try to imagine what tubes (if we shall have tubes) will look like thirty years hence, you are apt to wonder.

Take, for instance, our present-day detector tube. It is woefully inadequate (with regard to quality) and, compared to the crystal detector, it is exceedingly poor. This has lead a Western experimenter to substitute a crystal for a detector tube in his television set, with astonishingly better results in the quality of the received image.

But there are other things in radio of which we know practically nothing. Ever so often, we read of radio ghosts, explanations for which our best engineers are unable to supply. Suddenly, a frying pan, a faucet or a bed spring will emit music loud and clear. Evidently *it is* possible to have radio reception by totally different means than those which we are using today.

In New England recently, a frying pan started to emit music to the astonishment of the housewife. Perhaps you can say there was an aerial and ground in this instance, but what was the detector, and where was the amplifier? Yet, music there was, and evidently our best engineers today are unable to regularly produce music with such means. As usual, nature goes us one better and causes its own natural instrumentalities to do the same thing that we do in a most roundabout manner.

While radio phenomena of this kind have often been stressed, and while engineers have a vague idea as to how it all originates, yet, I do believe that if a little time and energy are used to work out the actual physics of such phenomena, an entirely new radio art might evolve in time. Nature is full of such "stunts," if only we might take advantage of them.

I spoke of the crystal detector before. While, of course, the vacuum tube is easier to handle, the "lowly" crystal still has its inherent qualities that will some day bring it back to its former popularity if it is properly "engineered." The crystal detector is full of mysteries as yet unsolved by radio engineers.

As every radio man knows, there is nothing really superior to the crystal detector when it comes to quality. What all of them do not know, however, is that the crystal has frequently been an excellent distance-getter, and there have been many verifications of this. For no known reason at all, the crystal, whose limit is usually about 15 to 25 miles, has been able to bring in signals from distances up to 300 miles.

Of course, the "wise" radio man will point out that this must be "freak" reception, and let it go at that, but when the same "freak" reception is duplicated hundreds of times they are no longer "freaks" but become pretty normal.

I proved this years ago in my *Interflex* circuit where I coupled a crystal to the grid of a vacuum tube. Taken alone, the crystal could not bring in stations more than 15 miles away. With the detector tube alone, the receiver could not bring in signals for a greater distance either. The two together (the tube now being used as an audio amplifier) brought in regularly stations as far as a thousand miles distant, and I can still duplicate this experiment today at will, bringing in stations on a 100-foot aerial from 500 to 1000 miles on any good receiving night.

Here then, is another radio mystery that needs exploring and that perhaps will lead us somewhere into something that we do not know today.

The trouble is that we take our present-day radio instrumentalities too much for granted. The chances are that we are working along entirely wrong lines, and it might behoove us to try a new path in order to gain knowledge which we do not possess today.

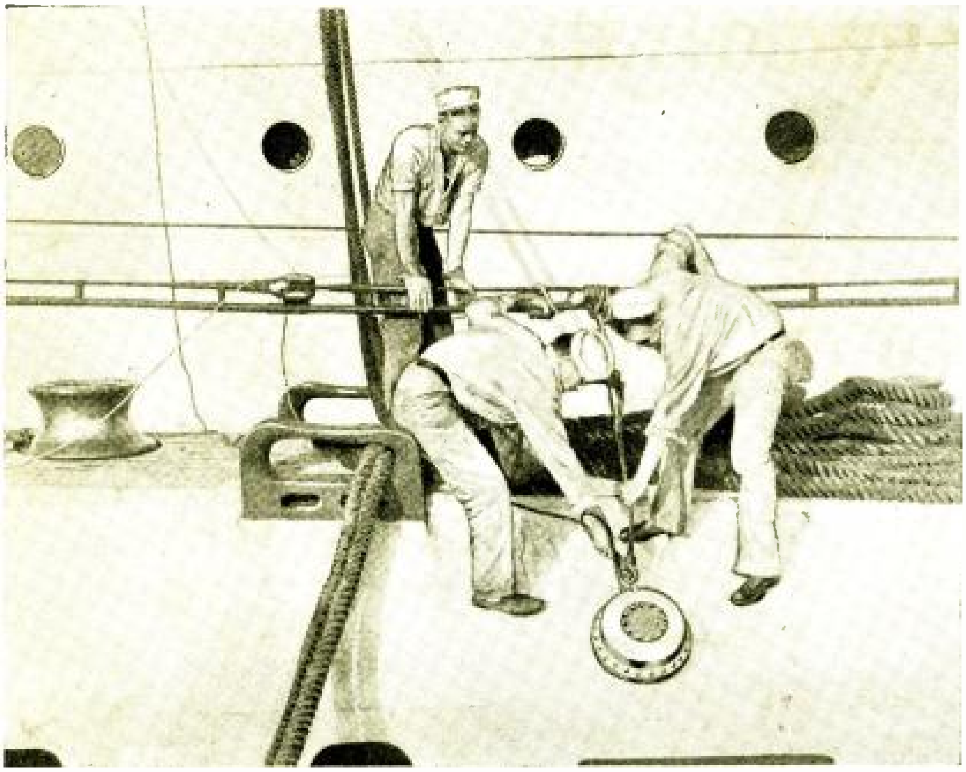


Fig. B. *The under-sea loud-speaker "stuck" to the hull of a submarine.*

Communication between sub-ships above has been attempted the system described by the way communication is derived

Submarine Hull Is

By GEORGE JAMES

WHENEVER man descends under the ocean's surface, he wants assurance on two points: first, that he will ascend again safely; and, second, that in the event mishap befalls him, he will be able to converse with those above who are seeking to rescue him from the engulfing waters.

These two considerations are of paramount importance and any means to minimize the dangers involved will further the public's confidence in submarine work. The importance of submarines in times of peace or war is not to be denied.

With the first consideration we are not technically concerned, although were it possible for guarantees to be made that no submarine ever would be trapped on the bottom of the sea, life-saving and communications apparatus would not be required.

With the latter, however, anyone familiar with submarines and their frailties must be concerned; and it is interesting to note that the U. S. Navy has given its submarine squadrons and their rescue vessels and mother ships a combination underwater radio and telephone that offers more peace of mind to submarine crews than any communications device yet perfected.

Simply and briefly, the device consists of a portable transmitter - receiver that operates from storage batteries on the deck of any rescue vessel (shown in Fig. A), several hundred feet of cable and a flat-sided round underwater reproducer that attaches itself *magnetically* to the metal hull of a sunken submarine, as illustrated in Fig. B.

Thus, direct contact is at once made and not made. While cap screws on the reproducer touch the submarine physically, the diaphragms—the heart of the reproducer—do not touch the submarine and the sound waves pass through the thin film of water separating them from the particular hull plate to which the device is attached.

Before offering a technical description of the surface and under-sea apparatus, let me give you a few of the high-lights of their functions and methods of operation. Later on, a detailed explanation will elaborate further the photographs and drawing accompanying this article.

Locating the "Sub."

Suppose a submarine, having submerged during a morning run, does not appear within an hour after its scheduled time for emerging from the green sea. Its squadron sets up a search, utilizing underwater radio sound apparatus; lookouts scan the sea for revealing oil blotches; grapnels drag the bottom in the vicinity where the submarine was last known to be.

Now, suppose they have found her through any of these methods. A rescue vessel steams overhead and drops anchors. Over the side, swaying as the surface ship rolls in the swells, the underwater reproducer is lowered away. The 200-pound metal piece disappears beneath the waves. As the cable lowers it, an operator sits at the deck apparatus as in Fig. A, his ears encased with telephones, his mouth close by a broadcasting transmitter, one finger holding down the "press-to-talk" button.

The magnetic qualities of the reproducer attract it to any magnetic substance in its vicinity, and soon the operator hears a metallic "ping" as it makes contact, and immediately he engages in two-way conversation with the trapped crew. Now, the beauty of the apparatus lies in the fact that all power is supplied from

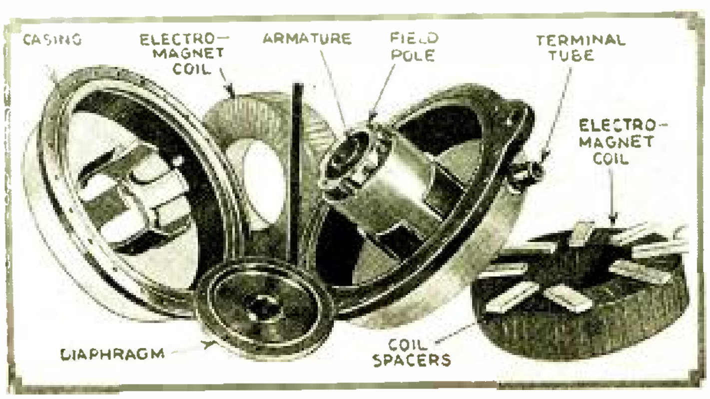


Fig. E
The component parts of the under-sea speaker are well illustrated.

marines in distress and rescue from almost every angle. In author, all power for two-from the rescue ship above.

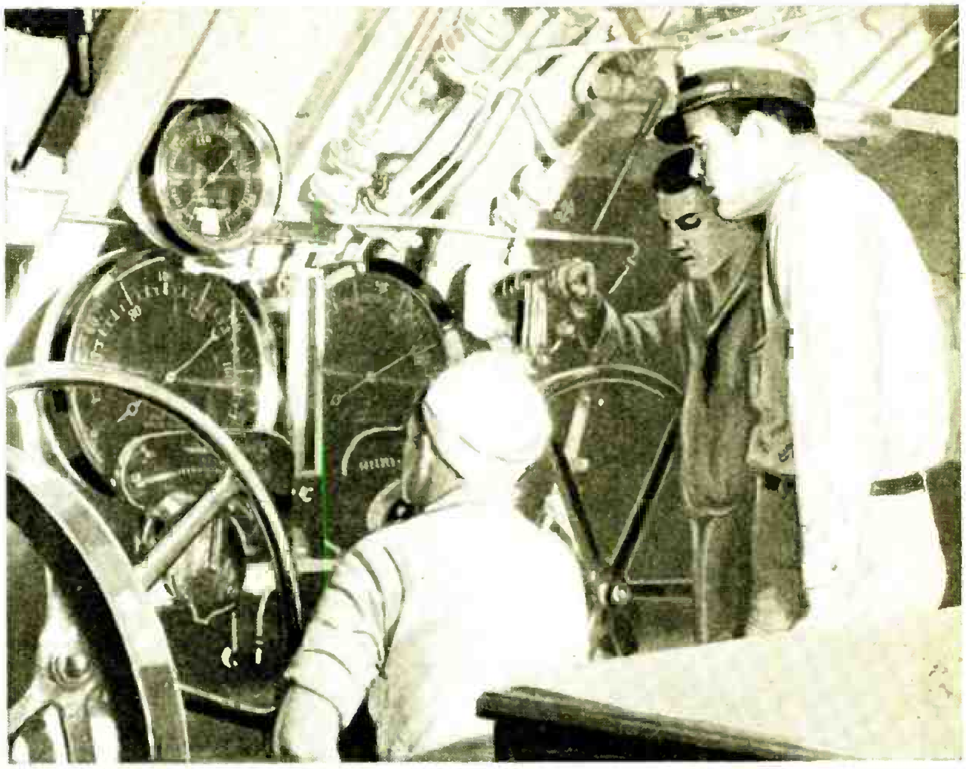


Fig. C. *Entrapped crew communicating with rescue ship above.*

"Mike" *and* Reproducer

above. The submarine supplies no current, nor does it possess any apparatus needed in completing contact and circuit. The hull acts as an acoustical receiver, and the crew, by raising their voices, can talk with ease to the operator above.

When Lt. W. M. Tinsley, navy radio materiel officer, and Philip T. Russell, associate radio engineer, completed experiments with the apparatus, the sets were supplied to the various rescue vessels with the several fleets. They now are available for conversation with American submarines no matter where they might go down.

As set forth in the report and instructions compiled by Lt. Tinsley and Mr. Russell, and as further elaborated at San Diego, Calif., by officers of the Twelfth Submarine Division, under command of Capt. W. L. Friedell, through whose courtesy these diagrams and photographs are reproduced herewith, a technical description of the apparatus and its functions follows:

Fig. A. *Operator on rescue ship talking to men in a trapped "sub."*

General Theory of Operation

After the speaker is lowered to the sub, the self-contained electromagnet maintains contact between the reproducer and the hull of the submarine. Sound energy as spoken into the microphone is transferred through the power amplifier to an A.C. coil in the speaker which in turn vibrates both diaphragms on the underwater reproducer. The nearer diaphragm transmits the sound through the intervening water space of about one-quarter inch to the metal hull plates which in turn are set in vibration in such a way as to generate sound waves to the air space within the hull. That is, the hull acts as an acoustical receiver. The voices of men inside the hull in turn vibrate the hull plates in the vicinity of the underwater reproducer, which carries these sepulchral voices from the bottom of the sea up to the vessel whose crew is attempting to rescue them, as in Fig. C.

These vibrations pass through the water to the nearer diaphragm of the speaker, which in turn produces more lineal oscillatory motion of the armature tube inside the speaker so as to generate electrical energy in the A.C. coil. This coil, when "listening," is connected to the input of the two-stage amplifier, thus giving enough energy in the 'phones clamped to the operator's ears so as to complete two-way conversations from the deck of the rescue ship down the cable and through the water and metal walls of the submarine.

The design of the reproducer is such as to anticipate its use in all kinds of diving operations.

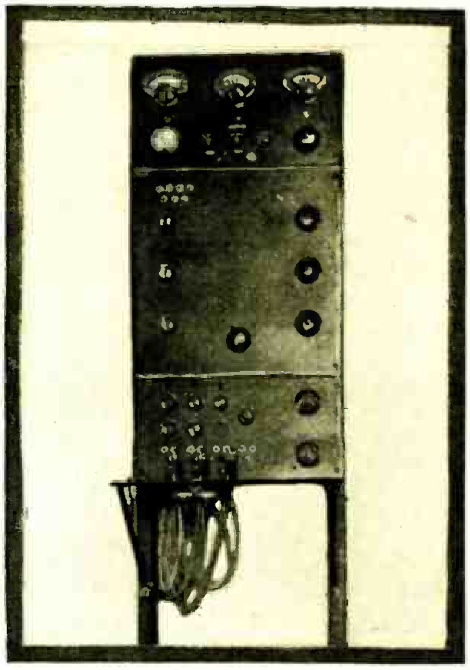
Practical use of the underwater telephone has demonstrated to navy experts that the diaphragm should not actually touch the

(Continued on page 552)

PERMEABILITY RECORDING

A new method of recording sound on wire by varying the permeability of the wire in phase with the sound to be recorded.

By PHILLIP BERNSTEIN



The amplifier used by the author during the recording process.

BEFORE beginning our discourse pertaining to a new means of sound-recording, let us briefly review some phases and details of the present and near-past arts of sound-recording, broadcasting and reproduction.

Since that great inventor, Thomas A. Edison, first commercialized his phonograph, the methods of recording and reproducing sound have changed very little, with the exception of sound-on-film. Of course, we now have the use of vacuum-tube amplifiers, high-quality microphones and pickups, and fine loud-speakers. However, the same bulky composition discs are used to a large extent with either the hill-and-dale, or the duo-lateral cut.

The Edison records make use of the hill-and-dale cut, which utilizes a constant-spiral, or a constant-screw track which varies in *depth* according to the sound impressions. The pickup or mechanical reproducer is then constantly varied in a vertical motion as the needle point moves up and down within the sound track. The duo-lateral cut, on the other hand, has a sound track of constant depth but which varies from *side to side*, according to the sound impression.

In the latter method, the pickup or reproducer moves back and forth in a horizontal position. This method is the most widely used, both in ordinary records and in tal'-ing movies.

The Telegraphone

Some time about the year 1900, V. Poulsen invented his famous telegraphone. It seems strange that an invention of this sort, although widely discussed at the time its patent was granted, should be so quickly forgotten. In fact, it has been rediscovered and reinvented a dozen times since.

The telegraphone is a method of recording sound on wire, disc, or tube by magnetic means. In brief, a steel wire, No. 28 B & S gauge, passes between the pole pieces of a magnet which is energized by a solenoid which, in turn, is energized by a microphone or an amplifier. The steel wire then retains a magnetic record which is reproduced when the wire is passed again through the pole pieces, this time with a pair of head-phones or an amplifier and loud-speaker attached to the solenoid.

The objectionable feature of this system of recording is that the magnetic impressions begin to expand, especially the higher frequencies. In a day or two, the record is almost indistinguishable except for the lower frequencies, the higher ones having entirely disappeared.

Some earnest investigators have tried to improve upon the Poulsen telegraphone, but the consensus of opinion seems to be that its fundamental and original faults cannot be overcome. The magnetic record simply will not stay permanent.

From London and Berlin, in 1929, we received reports that the Ludwig Blattner Picture Corp., Ltd., of London, and the Telegraphie Patent Syndikat of Berlin, associated companies, had succeeded in demonstrating talking motion-pictures with the sound record reproduced from magnetic wire. No reports have been received since then, although, at the time, it was claimed a more permanent magnetic record was produced.

What the industry needs at present is a record that will run one hour, two hours, or a whole day, without interruption!

A full hour's program for the home, be it sound or television or both, is one of the possibilities that may be secured by recording wire.

The author, for many years, has given thought to such a system and has realized the faults of Poulsen's method. A new theory along those lines was then developed.

Variable Permeability Recording

In a nutshell, what we propose to do is to vary the *permeability* or "magnetic resistance" of a steel wire, and this will be done with heat.

Annealing is a heating and cooling operation of a material in the solid state. Among the purposes are the following: (a) remove gasses; (b) remove stresses; (c) induce softness; (d) alter ductility, toughness, and electrical, magnetic or other properties; (e) refine the crystalline structure.

Read item (d) of the above paragraph and you will understand what we propose to do; but not exactly by annealing as ordinarily practiced.

(Continued on page 553)

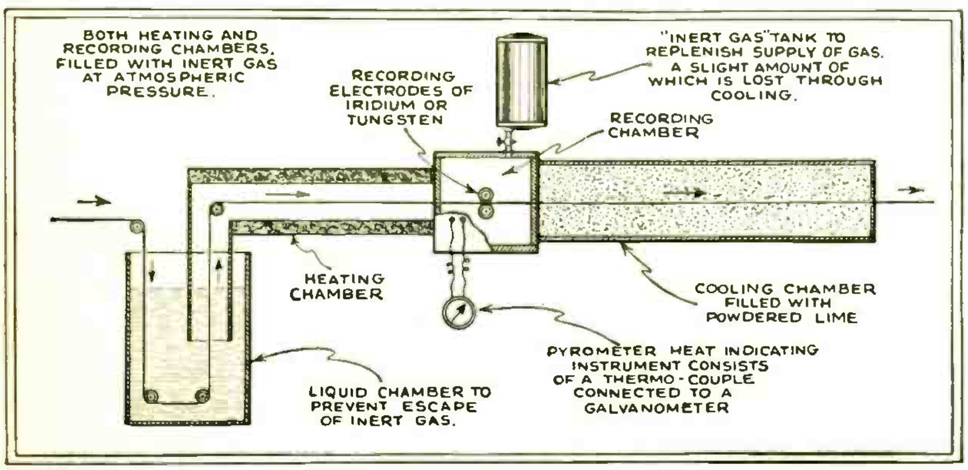


Fig. 1

Schematic circuit showing the path of the wire during the process of recording. The two rollers heat the wire above its critical temperature before the actual recording begins.

The Positive-Grid Tube

The high output required in public address work may now be secured by the use of a new positive-grid power tube capable of delivering 20 watts of undistorted output.

By LOUIS MARTIN

IN public address work, where relatively large power outputs are required, recourse must be made to the use of several tubes in a push-pull or parallel push-pull connection in order to secure the desired output. For such work, amplifiers are usually operated on the straight portion of the grid voltage—plate current curve in order to obtain an output that resembles the input in wave shape. When so operated, amplifiers are said to be of the class "A" type.

The main disadvantage of class "A" amplifiers is that a maximum efficiency of only 50 per cent may be secured—and this with the load impedance equal to the internal impedance of the tube. As is well known, any change of load impedance from this optimum value results in a decrease in efficiency. Furthermore, even with only 50 per cent efficiency, the output is not free from harmonics, and therefore the load impedance is usually made twice the tube's impedance in order to reduce the harmonic content of the output.

The Positive-Grid Tube

In some types of transmitting stations, the amplifier tubes are so biased that no plate current flows when the carrier is not modulated. When the grid swings positive, the plate current rises to a high value, but when it swings negative, the plate current remains at zero. The action is thus similar to that of a rectifier, and is illustrated in Fig. 1. When so operated, an amplifier is said to be of the class "B" type.

This method of operating an amplifier has several advantages and disadvantages. First, because the plate current flows for only half a cycle, it is distorted and special means must be employed to eliminate the harmonics that are present when the plate current is distorted. Second, since the grid of a tube that is so operated only functions during the positive portion of the grid voltage, the amount of grid current that may flow may be excessive and result in serious distortion of the grid voltage. The main advantage of the method is that, since plate current flows only during the positive portion of the cycle, the amount of heat that is generated per second is much less than if plate current flowed during the entire second.

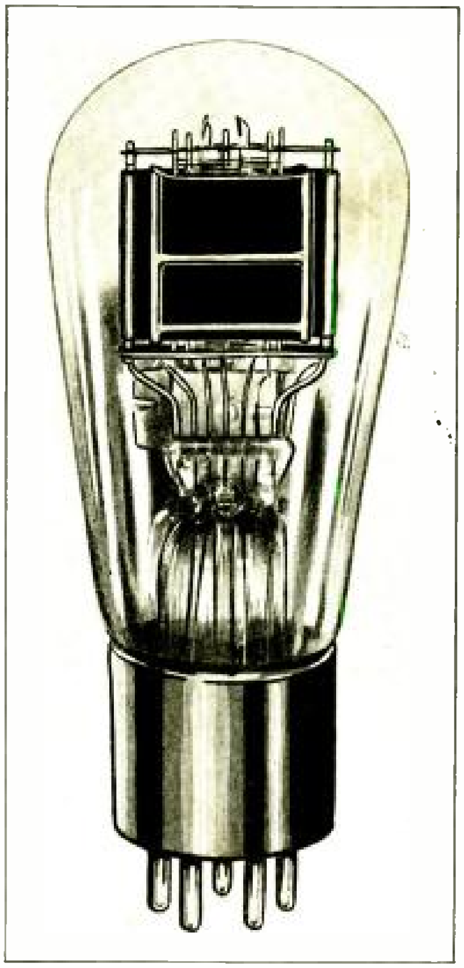


Fig. A
The positive-grid tube.

This latter condition means that the plate current *that may be made to flow* during the positive half-cycle can be increased considerably before the same amount of heating of the plate occurs. It should be recalled at this time that when the plate current through a load resistor is doubled, the power developed in that load is increased four times. Thus, an amplifier, biased as described above, may be made to develop considerable power output with the same plate-heating as compared with one operated as a class "A" amplifier. This is exactly what the new positive-grid tube, illustrated in Fig. A, is designed to do.

Technical Details

The plate current—grid voltage curve of the tube is illustrated in Fig. 2. Note that the plate current at zero bias is very small—for all practical purposes, zero. At A is shown the static, and at B the dynamic, characteristic of the tube. At C is shown the grid-current curve; at high values of applied voltage, it becomes quite appreciable.

To secure an output similar to that at B, Fig. 2, the plate-current cut-off at zero bias must be very sharp. To secure this condition, the tube is constructed with two concentric grids, the inner one being coarse in comparison with the outer one. A diagrammatic arrangement of the elements in the tube is shown in Fig. 3A, and in Fig. 3B are shown the socket connections.

The characteristics of the tube are as follows: Filament voltage, 2.5 volts; filament current, 1.75 amps.; Eg1 and Eg2, zero (both being connected together outside the tube); plate voltage, 300 volts; plate current, nearly zero; plate load, 1250 ohms; undistorted output, 20 watts; maximum peak grid-input voltage, 35 volts; total distortion (including 2nd, 3rd, 4th and 5th harmonics) 10 per cent. As the load impedance is increased to 2500 ohms, the distortion increases to 20 per cent.

Adaptations

This tube is primarily designed for public address work, and when used for such purposes, is designed to be driven by a '45 tube as illustrated in Fig. 4. Normally, the signal voltage appearing across the primary of the output transformer of a '45 tube is about 140 volts (peak). In order to drive the positive-grid tube, which requires a peak voltage of but 35 volts, the audio transformer T1 coupling the two tubes *must be step-down*, and have a ratio of about 4 to 1. The secondary of this transformer must also have a low impedance in order to minimize grid distortion. The output transformer T2, feeding into a dynamic speaker having a voice-coil impedance of 10 ohms, should have a ratio of 11 to 1.

(*Continued on page 554*)

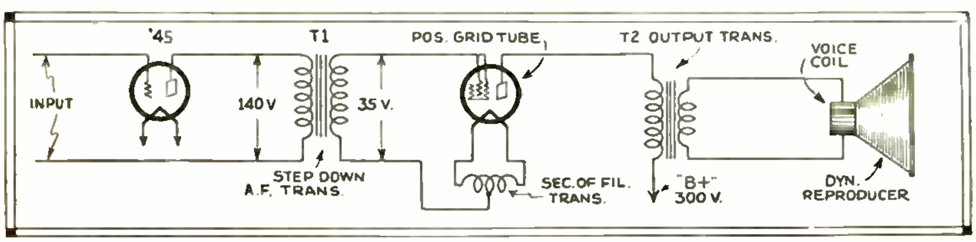


Fig. 4
Schematic circuit of the manner in which the positive-grid tube is to be connected.

The Latest in

RADIO EQUIPMENT

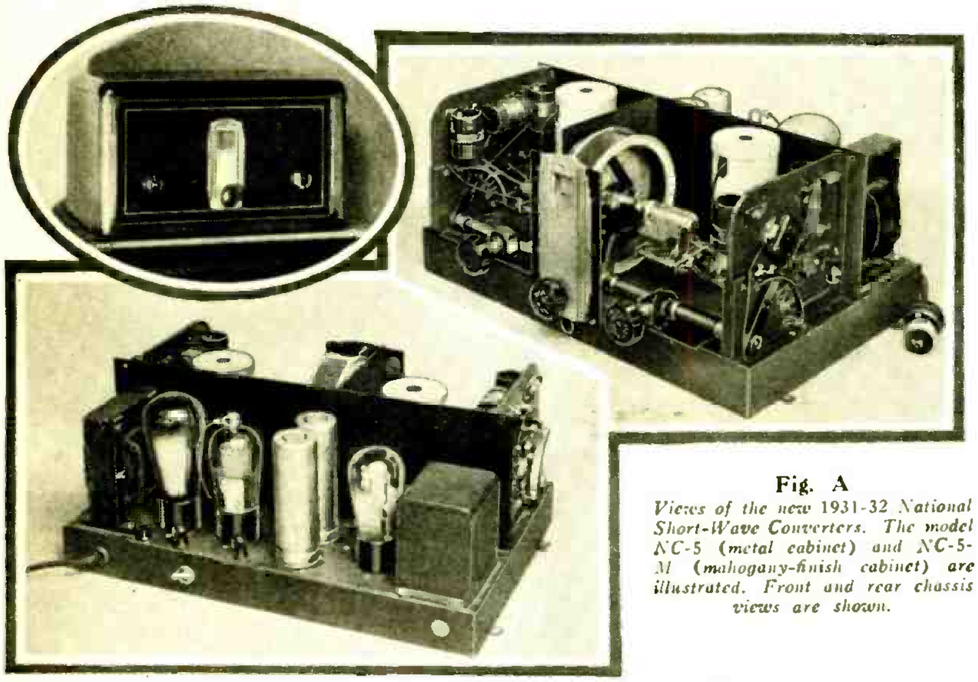


Fig. A

Views of the new 1931-32 National Short-Wave Converters. The model NC-5 (metal cabinet) and NC-5-M (mahogany-finish cabinet) are illustrated. Front and rear chassis views are shown.

AN EFFICIENT SHORT-WAVE ADAPTER

MODERN short-wave adapters are not to be confused with the older instrument designs which gave the field of short-wave adapter operation such a poor name amongst broadcast listeners who had been inveigled to purchase instruments built in accordance with earlier technique.

Of course, the short-wave fan was well aware of the latent possibilities of such devices, and accordingly he made generous allowances for operation below par.

Among the foremost short-wave adapters designed in accordance with the latest advances in the short-wave field is the new National 1931-32 5-Tube Short-Wave Converter; in Fig. A is illustrated the De Luxe Models NC-5 (metal cabinet) and NC-5-M (mahogany-finish cabinet), and in Fig. 1, the schematic circuit of these receivers. Variable-mu tubes are used in the first R.F. and oscillator stages. The wavelength range is 15 to 185 meters, as indicated in the tuning graph, Fig. 2.

First-detector—oscillator interlocking has been overcome by coupling the cathode circuits of these two tubes, as indicated in the diagram. (This method of coupling was discussed at considerable length in the constructional article, "The 'Antipodes' Short-Wave Super Converter," which appeared in the October, 1931 issue of RADIO-CRAFT.)

Undesirable "dead spots" in the tuning spectrum have been avoided by correct coil placement. Due to a harmonic action in the input circuit, which includes an R.F. choke coil, L, a high-impedance grid circuit is obtained without the use of a sharply-resonant circuit; at the same time, the antenna de-tuning effect is not reflected into the sharply tuned, and accurately-aligned circuits which follow.

A power pack, entirely shielded from the remainder of the converter, supplies all the required potentials.

The single stage of high-gain I.F. amplification, V4, serves the primary function of satisfactorily matching into the input circuit of any radio broadcast receiver, the tuned circuits and associated tubes of which become additional I.F. stages succeeding V4 in the converter. The recommended I.F. is 575 kc.

Interwound inductances (that is, primary and secondary coils wound together) are used, and the six individual tuning steps required to cover the entire tuning band (ordinarily accomplished with plug-in coils) are conveniently obtained by operating a small knob on the panel. This, in turn, works a switching system which moves two arms across two sets of contacts; these are located on opposite ends of the chassis, as shown in the illustrations. (Circuit aligning condensers also are located on these two panels.) An index of the particular two-winding inductance in use is the color of the illumination of the main tuning drum; at the same time, the approximate frequency setting of the receiver is thus indicated.

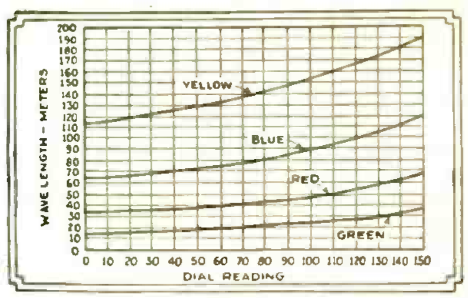


Fig. 2

Calibration curves of the National short-wave receiver. Note the parallelism of the various tuning curves.

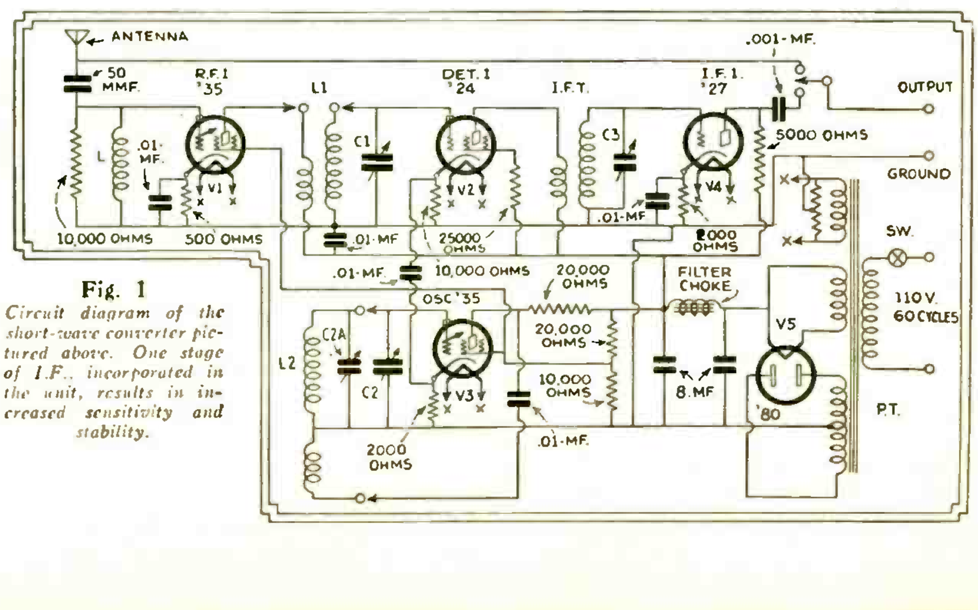


Fig. 1

Circuit diagram of the short-wave converter pictured above. One stage of I.F., incorporated in the unit, results in increased sensitivity and stability.

The latest devices are described here for the trade, Service Man, and home constructor. Follow this department from month to month for descriptions of the latest equipment used in the radio field.

The central knob of course controls the tuning drum; the small knob on the left operates the off-on switch.

The tuning graph, Fig. 2, clearly shows the manner in which one tuning range overlaps the next one; the ingenious, rotating pilot-light color-drum identifies the coil colors.

This short-wave converter (available for 60- or 25-cycle operation, and 110 or 220 V.) is recommended to those who wish a modern device, incorporating new "wrinkles" in converter design, for the reception of DX stations, via the standard 200-to-550-meter (1,500-500 kc.) broadcast receiver. The Models NC-5 and NC-5-M Short-Wave Converters are manufactured by the National Co., Inc.

RADIO MAGAZINE BINDERS

Fig. B
The Radio Library series of binders suitable for individual use. An embossed cover lends richness to their appearance.

COMBINING originality in design, richness in appearance, and convenience in their use, the new Radio Library series of binders, some of which are shown in Fig. B, fills a decided need long felt by the reader who preserves magazines of interest, and the technician who wants his data handy for ready reference.

There is a binder, appropriately stamped in gold for each of the popular radio magazines; and other binders in the series, some with "post" construction, are available for Data Sheets, correspondence course lessons, and technical leaflets. All of the binders are perfectly matched; consequently, they are suitable for the library shelf.

The binders are tan in color, and are made of a washable, pigskin-grain material which is embossed.

These binders are available from R.C.A. Institutes, Inc., and are sold in single units to meet individual requirements.

PROFESSIONAL RADIO TEST-SET COMBINATION

Fig. C
A portable set-analyzer, oscillator and power unit for the convenience of Service Men.

IN Fig. C is illustrated the new Pattern "531" Professional Combination. This set of test units, which includes a Pattern "444" Set Analyzer, a compact oscillator (very similar to the Pattern "563"), and a power unit that supplies power for testing all tubes independently of a receiving set, is designed for that rapidly-growing number of radio Service Men who consider their work in the light of a profession. This combination test unit is adequate for making all tests and adjustments on any receiver.

The analyzer and oscillator may be removed from the carrying case for convenient use in the shop or in the customer's home.

The Pattern "531" Professional Combination is manufactured by the Jewell Electrical Instrument Co.

A MODERN ANTENNA KIT

THE words, "antenna kit," recall to the mind of the average radio Service Man a coil of copper wire, some insulators, a ground clamp, some heavy rubber-covered ground wire, and perhaps a run of silk-covered lead-in wire; but the newest thing in antenna equipment, the Antenaplex Kit, Model RF-5000, illustrated in Fig. D, bears little resemblance to the previously described apparatus of earlier vintage. (It includes an "antensifier box," "cabloy," "cabloy clamps," "taplets," "outlet flush plates," and a "terminet." The up-to-date Service Man must familiarize himself with these new terms.)

As described in the October, November, and December, 1931 issues of RADIO-CRAFT, the most effective antenna installation, from many standpoints, includes the use of a

Fig. D
The Antenaplex for store use.

vacuum-tube pre-amplifier and multiple distribution system—the "Antenaplex," an interference-free method of installation.

Previously, this method of "centralized" installation has not been available to the independent Service Man wishing to install the apparatus in apartment houses, hospitals, and other new or existing structures where multiple radio reception is desirable. The new "Antenaplex Kit" makes available to these men all of the apparatus necessary for one complete installation capable of serving any 10 broadcast receivers with exceptional antenna facilities.

In the kit are found the following items: one antensifier box, No. RF-5001; one antensifier No. RF-5002; 100 ft. cabloy No. RF-5050; 100 cabloy clamps, No. RF-5055; 10 taplets, No. RF-5031; 10 radio outlet flush plates, No. RF-5634; and one terminet, No. 5091.

This Antenaplex kit is manufactured by RCA-Victor Co.

MOTOR RADIO SUPPRESSOR KITS

Fig. E
A complete auto noise-suppressor kit.

ELECTRIC noises generated by the electrical system of the automobile and interfering with the enjoyment of the auto-

(Continued on page 555)

Improving An AUTO RADIO

In this article, the author outlines some of the problems that were encountered in the design of an automobile receiver and describes the methods used to overcome them. Just how he proceeded, makes interesting reading.

By OSCAR BLOCK

THE trials and tribulations of the makers of automobile radio sets are many; all too often the greatest profits made from these sets have accrued to the purveyor of hair dyes to whom the harassed and grayed engineer has finally been driven.

Recently it was the writer's pleasure (?) to become acquainted with some of these problems. The results of his labors are embodied in the description of the set illustrated in Fig. A which is the basis of this article.

Before taking up the constructional details of the set itself, a brief review of the major difficulties to be encountered in this field will perhaps be of interest. These are, in the order in which they rank, as follows:

(1) The inadequacy of the signal pickup system (i.e., the antenna and ground substitute) for furnishing a large signal input;

(2) The difficulty of obtaining a high gain in a very small set;

(3) The close voltage limits within which the type '36 tubes must be held to secure a maximum of efficiency (this is distinctly at variance with the claims made for the tube which, supposedly, was designed to be non-critical as to these factors);

(4) The difficulty of providing in an automobile set, where the leads are long, a satisfactory volume-control that shall operate in the R.F. stages without introducing a loss of amplification, audio howling, R.F. oscillation or tube blocking.

In solving these problems, it would also be well if we could achieve an equality of gain throughout the broadcast band so that our little automobile set would be in no way inferior to its big brother, the home radio set.

Analyzing the Problems

Analysis of these factors at once rules out the first item from consideration; we can do nothing to secure a good pickup in a moving car without adopting unsightly and impractical expedients. Since our little set

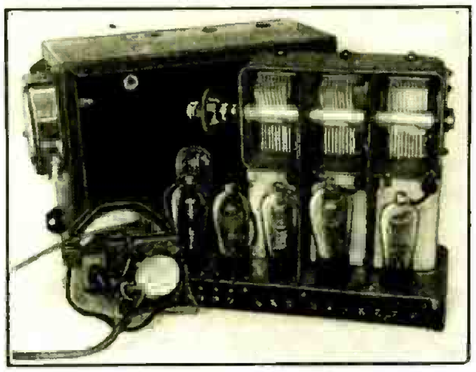


Fig. A
Photograph of the efficient automobile receiver described by Mr. Block.

shall indeed have to be long on performance, in it we shall incorporate high-gain high-primary-inductance R.F. coils, carefully isolated R.F. circuits, and the maximum of regeneration possible.

We shall do away with taps on our "B" batteries and shall use, instead, a voltage-dividing system; since by this method we can hold our voltages within closer limits and, once adjusted, our set shall be more nearly independent of battery fluctuations than would otherwise be the case.

As to the volume-control circuit, we have adopted a really simple expedient that at once removes our control from any signal circuit and allows us to operate our tubes at their most critical point without in any way increasing the fear of oscillation or tube blocking.

Novel Volume-Control

In Fig. 1, this circuit is outlined. Here R1, R2, R3, and R4 form a voltage-divider circuit across the "B" supply. R1, R3, and R4 are fixed resistors; R2 is variable. Any variation in R2 will change the current flow through the resistor network and, of course, change the voltage drop through each resistance. Thus, if the resistance of R2 is decreased to reduce the amplification, the increased current flow through the circuit results in a simultaneous decrease of the plate and screen-grid voltages, as well as an increase in the negative grid bias; in combination, these provide infallible volume-control. This means of control gets away from the increase in plate and screen-grid voltages which accompanies the conventional control-grid bias-variation methods where the plate and screen-grid circuits are fed through resistances.

Further, this method defeats the detection which often results at low volume in an R.F. stage when the screen-grid bias is reduced. (Such detection is the result of low current through the cathode resistance causing too-low control-grid bias.) Another advantage of this method of control is that howling, which sometimes comes as the result of the screen-grid's voltage becoming close to that of the plate, is made impossible. Such a condition is apt to occur when, as the result of decreased screen-grid current or increased plate current, the altered voltage drop through the filter resistances tends to equalize the plate and screen-grid voltages.

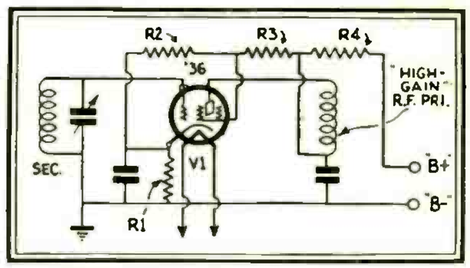


Fig. 1
A novel method of volume control; resistor R2 is variable.

The smooth operation of this control is no small factor in allowing the close voltage settings which the type '36 tube requires for peak operation and which no other *simple* method can insure.

Uniform R.F. Gain

We have mentioned the desirability of providing uniform over-all gain throughout the broadcast band. Mechanical means through movable primary coils could be used but for the ideals of compactness and

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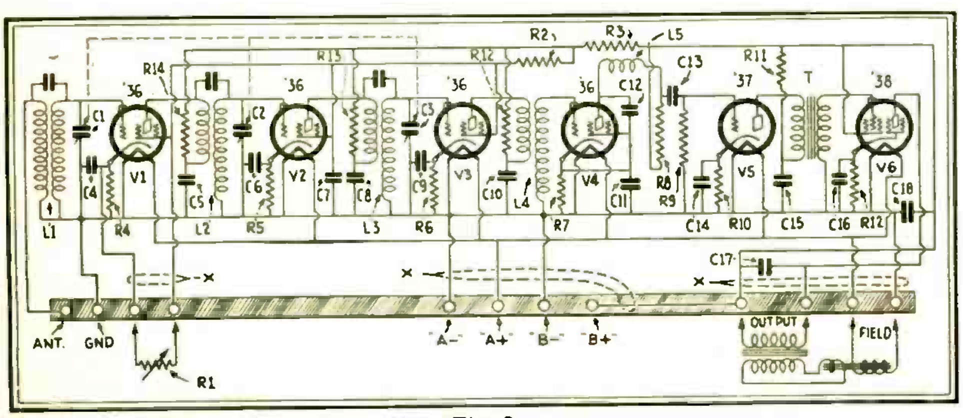

Fig. 3
Complete diagram of the auto receiver. The values of the resistors are such that practically no changes in plate and screen-grid voltages result when the volume is changed.

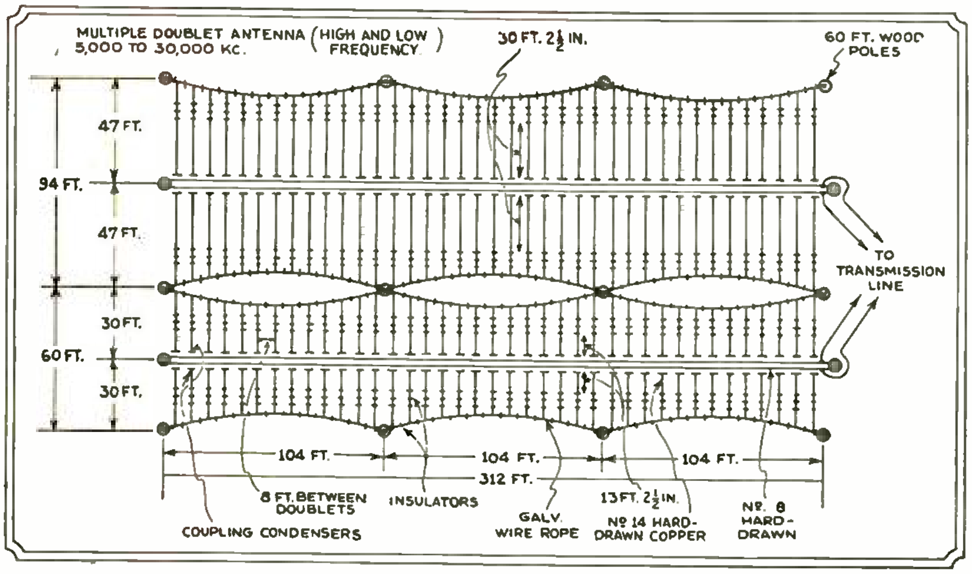

Fig. 2

The multiple doublet antenna system at Grand Island, Nebraska. The lines are terminated with a 410-ohm resistor to prevent reflections.

The antenna system used at the U. S. listening station is complete in every detail, and is fully described in the accompanying description.

U. S. *Monitor Station*

(Part II)

MUCH thought was given to the antenna systems. It was early decided that if the station were to cover international channels, it should have many directional high-frequency antennas, similar to those used by communication companies. However, the Division had a different problem on its hands than most of these companies. For the most part, the communication companies monitored only a few channels, while the Radio Division proposed to monitor the whole radio spectrum. For this reason, antennas which were both *aperiodic* and *directional* were needed, or else the cost would be prohibitive.

A Beverage-type antenna was chosen to cover the broadcast range from 550 to 1500 kc. This antenna as used at Grand Island is a single wire 1400 feet long, suspended on sixteen-foot poles spaced 100 feet apart. It points to New York City. The operation of this antenna depends upon the wave tilt. The wave tilt, in turn, is dependent upon frequency and soil resistance. Every space-wave can be vectorially divided into two components, commonly spoken of as horizontal and vertical. The horizontal component is more directional than the vertical. The Beverage antenna has the property of picking up the horizontal voltage component to a much greater degree than the vertical. In very long antennas, this ratio is about 100 to 1.

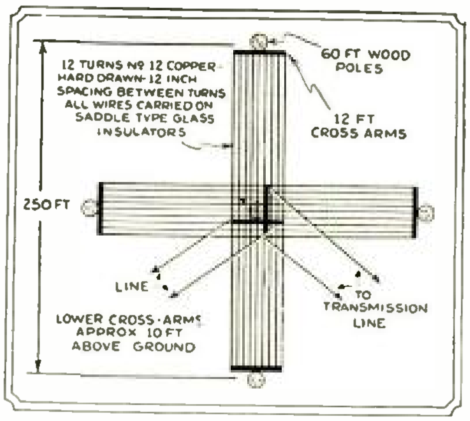

Fig. 4

The special loop antenna. Designed to cover the frequency range from 10 to 100 kc.

As the space-wave advances over the antenna, increments of horizontal voltage are induced in each increment of wire. These voltage increments travel along the wire at very near the velocity of the space-wave. Therefore, each one adds up in phase, and the voltage wave on the wire reaches a maximum at the receiver end. The far end is terminated in a resistance equal to the surge impedance of the line so that back-end signals are dissipated, and prevented from being reflected back to the receivers. The proper value of this resistance for the Grand Island antenna was found to be 550 ohms. This is illustrated in Fig. 1.

Antenna Lengths

There are very definite lengths of antenna for maximum signal and maximum directivity. These two do not usually coincide, so that a compromise must be made. The usual method of finding the correct length for maximum signal is to set up a constant-frequency, constant-power-output oscillator, some distance from the far end of the antenna, and use a vacuum-tube voltmeter at the output of a receiver to test for maximum signal with different lengths of wire. The best length for directivity is then found by circling the antenna with the transmitter, using different lengths of antenna. The proper value of resistance is best found by setting the transmitter in the rear of the antenna and changing the resistance until a minimum signal is noted.

As the length of antenna is shortened, the ratio of horizontal to vertical pickup approaches unity, and the antenna loses its

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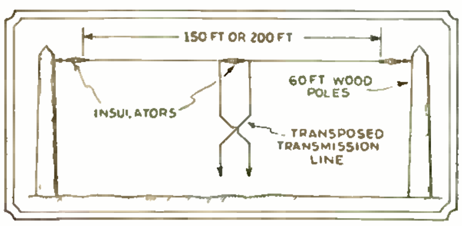


Fig. 3

Diagram of the "general purpose" antenna used at Grand Island.

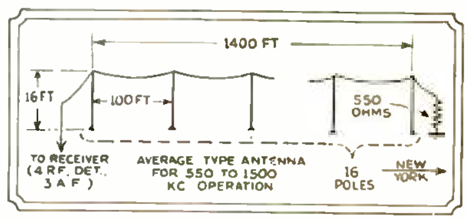
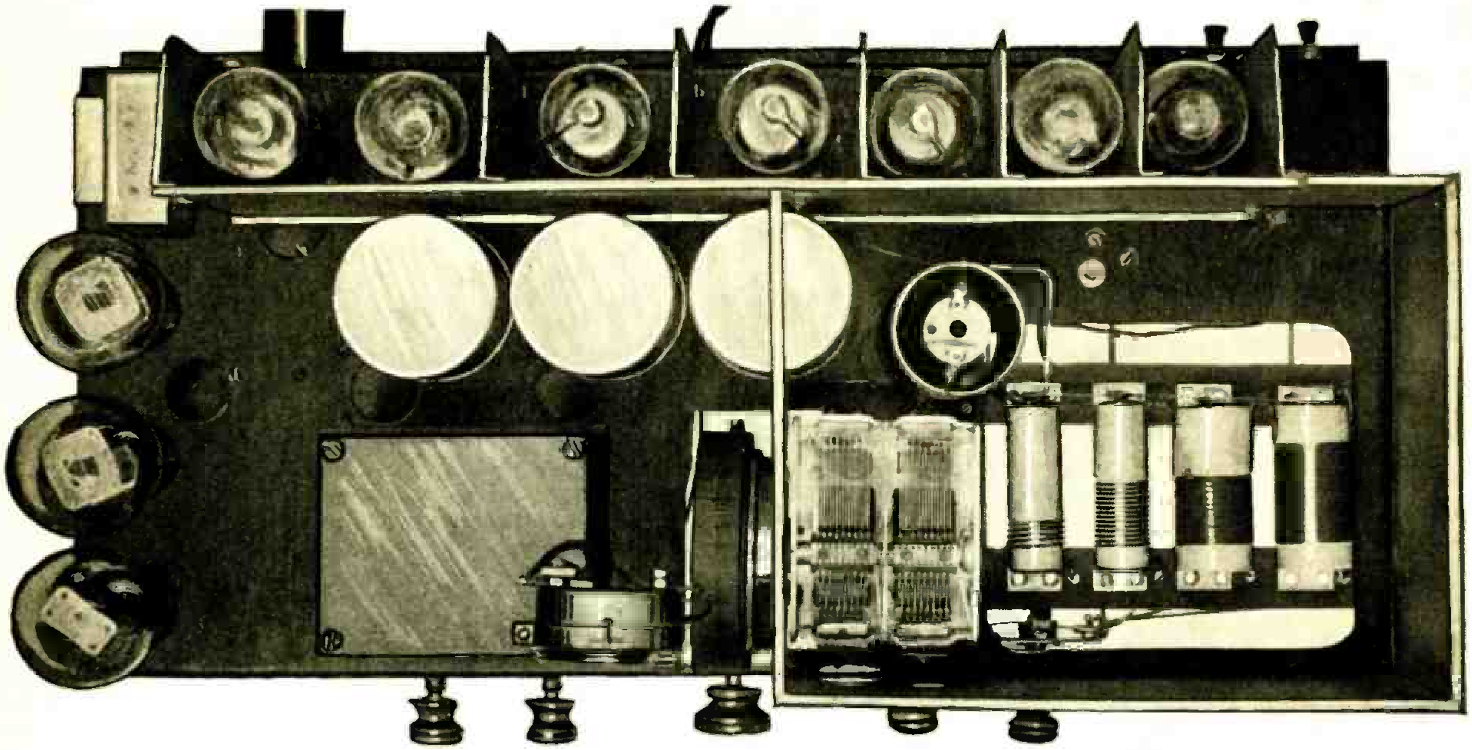


Fig. 1

The 1,400-foot Beverage antenna used at the U.S. listening station at Grand Island, Nebraska. It is terminated with a 550-ohm resistor to prevent surges.



A New S.-W. Receiver

A discussion of a new short-wave receiver embodying a unique feature in oscillator tuning. A complete and timely discussion of this receiver is given below.

By McMURDO SILVER*

UPON the introduction of the eleven-tube short-wave and broadcast superheterodyne, known as the S-M 726SW, last June, it was felt that it was the last word in short-wave-receiver design. In spite of its relative simplicity in relation to its performance, it was not as simple as could be desired. Unfortunately, no means was known of, even undeveloped, which would permit of, for instance, a simpler coil-selecting arrangement for the short-wave bands; or which would permit elimination of certain unpleasant, but not really detrimental, sounds of the nature of "burps" which occurred as the short-wave dial was tuned because of a few unavoidable reactions between harmonics of the broadcast and short-wave oscillators.

As no method was known for eliminating these two drawbacks—they were only slightly unpleasant rather than really detrimental—it was believed that nothing better could be hoped for.

But in November 1931, during the course of development work in an attempt to devise a better, or at least a simpler, system, some experimenting was done with autodyne first-detectors. While nothing satisfactory resulted, an idea was found by Kendall Clough, which now fully worked out, bids fair to be one of the greatest contributions to short-wave-receiver design that has so far been found. It at once simplifies the tuning of short-wave superheterodynes, eliminates most of the switching necessary in sets not employing plug-in coils, and does away with all "burping" on short-waves due to oscillator reactions. Six months ago, this method had not even been dreamed of—today, it is a practical, operative reality in several thousands of sets now in use.

While the autodyne detector system appears attractive at first glance, it has two drawbacks which render it worthless in a "super." The first is its absolute inability to discriminate against image-frequency interference, since every signal is impressed directly on the one tuned circuit of the combined oscillator-detector tube. The second drawback is that, since this circuit must be tuned *away* from the signal frequency by the intermediate-frequency to produce the necessary heterodyning action, and as on short waves this I. F. will be quite high, much loss of signal voltage results, particularly on the lower signal frequencies. The autodyne action is quite simple—but the new Clough system is equally simple, has none of the autodyne's drawbacks, and is in no sense related to the autodyne system, since it employs a separate and distinct detector and oscillator with their separate tuned circuits.

The Clough scheme is to use only one oscillator in the set, which must tune from 16.5 to 550 meters, or 18,000 to 550 kc. Offhand, this sounds impossible, and it is, for even the harmonics of the oscillator are too weak to be of direct use. The crux of the idea lies in the use of a tube directly coupled to the oscillator, which is so set as to tune over the broadcast band of 550 to 1500 kc., this tube acting as a harmonic generator and providing the necessary local frequencies to heterodyne signals in the 16- to 35-, 35- to 65-, 65- to 100-, and 100- to 200-meter short-wave bands.

This system results in only one permanently connected and aligned oscillator circuit, the harmonic generator tube providing the required heterodyne voltages for the short-wave bands. A single selector-switch knob gives a choice of five separate coils to enable the first-detector to cover the four short-wave and broadcast bands. In the final embodiment, one dial tunes the broadcast band, this same dial plus an auxiliary trimmer tunes the short-wave bands, and one five-position switch selects the five bands at will.

* President, Silver-Marshall, Inc.

It may be well to allay skepticism before describing the features of the system by stating that the receiver illustrated and described herewith, and embodying this new system, shows a broadcast sensitivity on the order of better than 2 to 3 microvolts absolute input for standard output; absolute 10-kc. selectivity with no image-frequency or cross-talk interference; a fidelity curve, from antenna to ear, flat to a few decibels from 40 to 4000 cycles; and 5 to 6 watts of undistorted power output—so there must be merit to the Clough system, even if it is brand new.

Choice of the I. F.

The salient points being many and closely interrelated, it is a little difficult to present them simply and concisely. One of the first points, for example, apparently having little bearing on the oscillator harmonic generation idea, is the choice of intermediate amplification frequency. Since only one is used, as against two in the 726SW, for instance, it must be selected carefully with respect to both broadcast-band and short-wave operation. The ideal broadcast-band intermediate-frequency of 175 kc. is almost worthless below 200 meters, and the next logical step is to 465 kc., which gives the advantage of "one-spot" operation over all but 2% of the broadcast band (1480 to 1500 kc.), as well as being very satisfactory for short-wave reception. Using 465 kc. for the I. F. simplifies image-frequency interference in the broadcast band to a point where it can be handled nicely by one high "Q" tuned circuit ahead of the first-detector, as compared to the two tuned circuits invariably needed with a 175-kc. I. F. amplifier.

This is a considerable gain in simplicity, but brings in another problem, that of I. F. harmonic feed-back from the second or audio detector, which will appear at multiples of the intermediate frequency, or 930 and 1395 kc. By careful arrangement of parts and filtration, this can be eliminated, and no "tweets" will be apparent on the broadcast dial at these frequencies.

Throughout the 550 to 1500-kc. broadcast band, the arithmetic selectivity is not as high as might be desired, but it is adequate with today's improved engineering technique of I. F. amplification, and it is very good on the short waves. A 465-k.c. I. F. permits also of entirely adequate image-frequency selectivity on short waves, the frequency separation at 20 meters, for instance, of the two oscillator settings, serving to heterodyne a given signal, being 6%, which may be satisfactorily discriminated between by one high "Q" tuned circuit ahead of the first-detector as has been proven in practice.

The Harmonic Generator

Fig. 1 shows in diagrammatic form a simplified example of the harmonic generator arrangement used to produce the short-wave heterodyne frequencies. Tube V1 is the '24 screen-grid first-detector, with its tuned input circuit represented by five coils, all designated L1, selected by the five-point switch to cover the five different bands, and tuned by the condenser C1. Tube V2 is the oscillator, L3 representing its plate, tank tuning, and grid coils. Tube V3 is the harmonic generator, across the plate coils (L2) of which are developed the required short-wave heterodyne voltages, the coils L2 each being properly coupled to the short-wave coils L1.

For broadcast operation, one set of L1 coils covers the band of 550 to 1500 k.c., and the fundamental oscillator range is therefore the sum of these limit frequencies plus the I. F. of 465 kc., or from 1015 to 1965 kc. The oscillator is coupled to this L1 coil in a manner not shown in the diagram of Fig. 1, for simplicity, and serves to heterodyne all broadcast signals to 465 kc. for the I. F. amplifier. When so used, the harmonic generator tube V3 is not utilized. If the band-selector switch is now turned to the second L1 coil, the useful tuning range of the first-detector will be about 90 to 200 meters, and the oscillator is obviously useless to heterodyne signals in this range to 465 kc. But now the harmonic generator tube V3 is utilized, and its grid circuit, directly coupled to the oscillator plate circuit, is fed frequencies in the range of 1015 to 1965 kc. by the oscillator. V3 is biased well below its cut-off point so it draws no plate current when not fed by the oscillator, and acts as a rectifier or, more properly, as a frequency multiplier. In its plate circuit, therefore, will appear a multitude of multiples of the oscillator frequency, or harmonics, which will be progressively weaker, as the harmonics increase.

In the discussion of this receiver (type 727) tube V3 is referred to as a "harmonic generator." In reality, it is a coupling tube between the oscillator and the first detector. Its presence is very desirable since it increases the stability of the oscillator, allows the oscillator to be shielded from the rest of the set, and stabilizes the output.

If the second harmonic of the oscillator is now considered, it will be seen to be 2030 to 3930 kc., from which we must subtract the 465-kc. I. F. to determine what signal frequencies it will satisfactorily heterodyne in this set. We find that this range will be 1565 to 3465 kc., or from just below 200 meters to about 87 meters. (There is apparently a gap of 65 kc. between the broadcast band and the 90- to 200-meter band, but

(*Continued on page 559*)

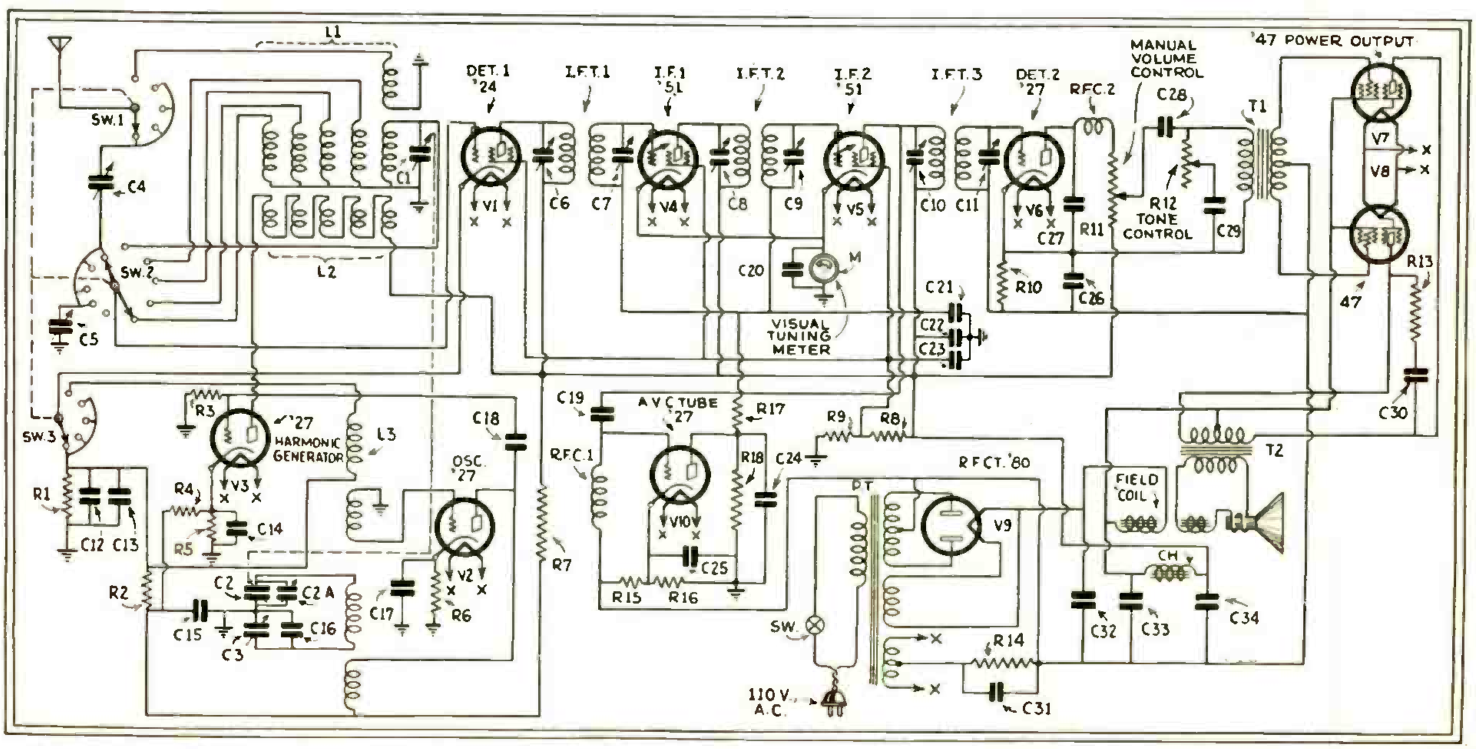


Fig. 2

Schematic circuit of the new Silver-Marshall short-wave receiver. Tube V3 is the "harmonic generator" whose output beats against the incoming signal to produce the intermediate frequency of 465 kc.

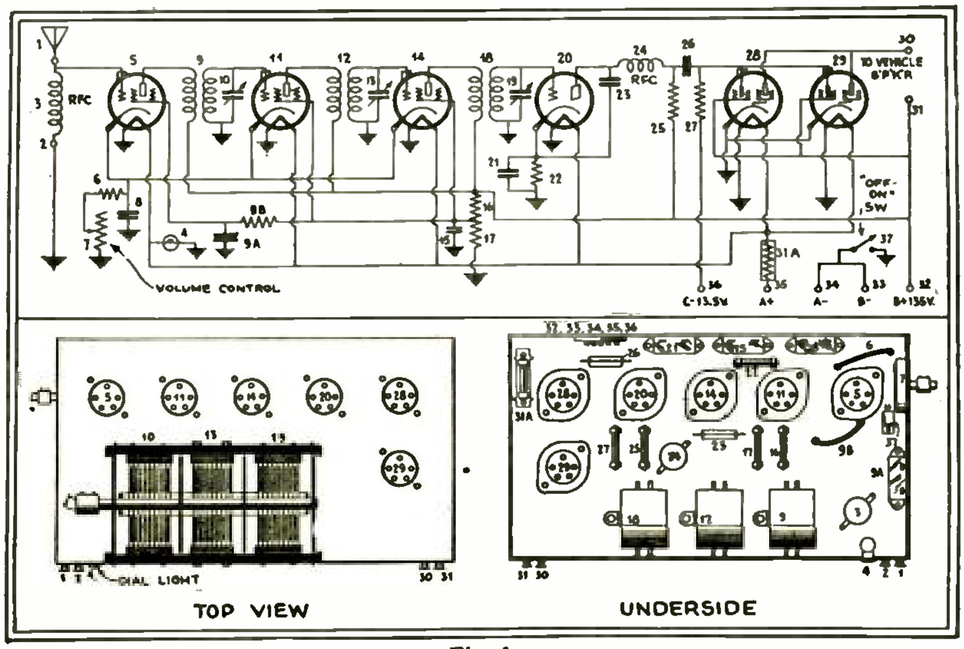


Fig. 1
Above, is illustrated the schematic circuit of the very versatile automotive receiver described by the author. Top and under views are also shown.

Complete construction data for a six-tube, screen-grid automobile receiver. The new automotive tubes are used in a circuit of high efficiency. This receiver is recommended for those who desire to "roll their own."

The "Screen-Grid 6"

Modern Automotive Receiver

By H. G. CISIN, M.E.

MANY recent developments in automobile radio-set design have been incorporated in the "Screen-Grid Six" automotive receiver. Furthermore, a unique circuit has been worked out for the purpose of utilizing the modern "automotive" or heater-type 6.3-V. (filament) tubes and all the other special components at the maximum degree of efficiency. The circuit employs three R.F. stages (the first untuned and the other two tuned), a tuned detector stage, and a single audio stage using pentode tubes *in parallel.*

The two pentodes have an undistorted power output of 375 milliwatts each. Since they are in parallel, they have a combined undistorted power output of 750 milliwatts. Furthermore, *their combined output impedance is lowered to 7500 ohms.*

The second and third R.F. stages and the detector are tuned by means of a three-gang condenser having shields between each section. High-gain shielded R.F. coils are used. Those specified are ideal for automobile sets, since they are only 1 9/16 ins. high and 2¼ ins. in diameter.

The dynamic "vehicle" speaker used has been designed especially for this type of work; its cabinet is compact, ornamental and serviceable. The car antenna specified fits underneath the running board. It is equipped with a non-shorting lead-wire and with a special rubber splash-guard. This new device gives better results than can be obtained with a roof antenna (unless installed in the roof when the car is built), and at the same time eliminates the possibility of damaging the top of the car. A "silencer kit" is used to eliminate noises from the ignition system of the engine. The steering column control is equipped with an illuminated dial and key lock-switch. This is operated by means of a flexible shaft, or else a solid shaft with universal joints.

Holes are drilled in the chassis for the six tube-sockets and also for the plug socket on the rear wall. All seven sockets are then mounted. The chassis is turned upside down and the volume-control is mounted on the side wall. Next, the four 1-mf. condensers are fastened in the positions indicated. The R.F. chokes 3 and 24 are then mounted and also the amperite 31A and the mica condensers 23 and 26. These reference figures will be noted in the schematic circuit, Fig. 1.

The three R.F. coils 9, and 12 and 18 are mounted horizontally as shown, using small right-angle brackets. The four binding posts are mounted on the front wall. The other parts are fastened in place during the process of wiring. However, before the wiring is started, the three-gang condenser is mounted on top of the chassis.

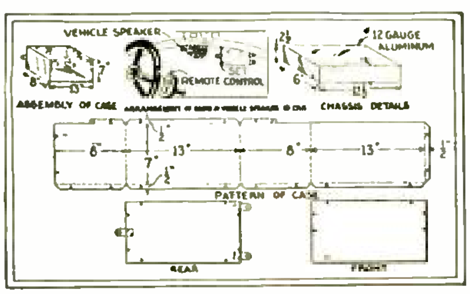


Fig. 2
Construction details which aid in the building and mounting of the receiver.

With the exception of the flexible leads, going to the caps of the type '36 and '38 tubes, all wiring is concealed beneath the chassis. The filament circuits are wired in first, grounding to the chassis all the negative terminals of the sockets. The "A" minus and "B" minus posts are connected together, the lead then going to switch 37. The other side of the switch is grounded to the chassis, which acts as the common negative return. At the battery box "C" plus is connected either to "B" minus or "A" minus.

The grid circuits are wired next. The connection from the antenna end of R.F. choke 3 is brought up through a hole drilled in the chassis, to the cap of the tube 5. The stator of condenser section 10 connects to the cap of tube 11. The stator of section 13 goes to the cap of tube 14 and the stator of section 19 goes to the cap of tube 20. The lead from the junction of condenser 26 and resistor 27 also connects to the caps of pentodes 28 and 29. Having completed the wiring to the caps, there can be no difficulty in making the double grid connections at the "G" terminals of the sockets. Plate circuits are wired, then cathode circuits, and finally bypass condensers and pilot light.

(*Continued on page 560*)

ELECTROLYTIC
Variable Condensers

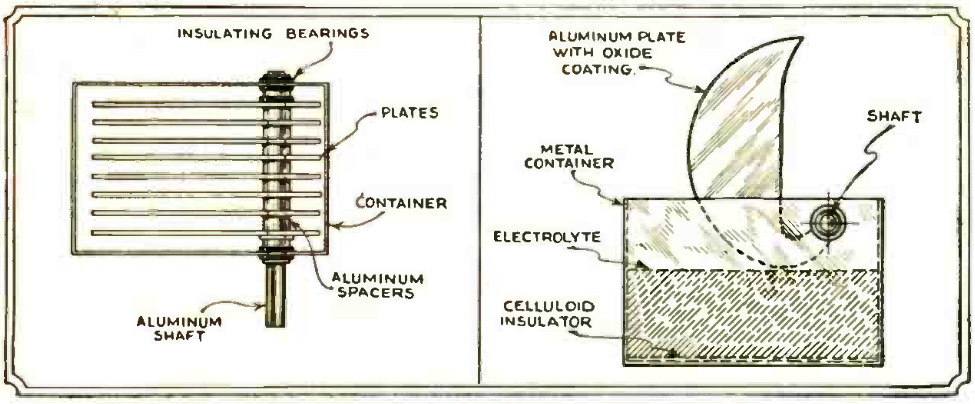


Fig. 1, left. *Assembly details of the electrolytic variable condenser.*
Fig. 2, right. *The condenser in its container. Note the height of the electrolyte.*

Experimenters have long waited for a variable condenser that would have a maximum value of about 4 mf. Radio-Craft presents such a unit to its readers.

By W. W. GARSTANG

IN the field of experimental radio engineering, there is often a need for variable high-capacity condensers. In the design of filter systems, it would be of inestimable value to be able to turn a knob until the hum level was of the required value, then simply read the amount of capacity necessary from the dial. A unit of this type, in order to be of value, would have to vary between, at least, 0 and 4 mf. There is little doubt that a variable condenser of this type would find use in the amateur transmitting field or, perhaps, for use in audio oscillators.

With this in mind, a condenser was designed. It is a unit of simplicity which can be constructed in any experimenter's laboratory.

The condenser is, of course, an electrolytic unit. It is based on the design of the variable air-condenser used so extensively in modern-day radio. The plates are of aluminum and the rotor is placed in a container filled with an electrolyte. As the rotor is turned, the plates dip into the electrolyte, thus producing a two-element electrochemical condenser. The degree to which the plates are immersed regulates the amount of capacity of the condenser.

The electrolytic condenser is a condenser having two elements, the anode and the cathode. The anode element is made from aluminum with a thin coating of aluminum oxide on its surface. The cathode may be of any metal, but is preferably made from aluminum or copper.

While the mechanical construction of this high-capacity variable condenser is simple, the electrochemical procedure is not as easy. The application of the anodic film and the mixing of the electrolyte must be done with precision.

In Fig. 1, the condenser may be seen completely assembled. In Fig. 2, the shape of the rotor plates is seen. The odd shape is necessary in order that the rotor, when in its position of minimum capacity, out of the solution, will not cause the liquid to flow or drip back onto the shaft causing leakage around the bearings. The plates should be made of aluminum that is at least 99.5% pure, but it has been found that, for condensers which are to be operated below 400 volts, aluminum plates taken from old variable air-condensers will answer the purpose quite well. The shaft and the spacers used in the assembly of the rotor must also be of aluminum. The bearings which hold the rotor shaft must be made of some material which has good insulation qualities and which will not be affected by acid or alcohol. Bakelite is an ideal material for the bearings and may be easily turned on a lathe.

Coating the Anode

To obtain the oxide film on the rotor assembly, the assembly is suspended in some aluminum utensil which has been filled with a solution consisting of 13 ozs. of boric acid, 1 oz. of borax, and 1 gallon of distilled water. It is of great importance that the aluminum utensil and the rotor be cleaned, and that the chemicals used be pure (U.S.P.). The rotor and the aluminum utensil may be cleaned by scrubbing in a warm solution of sodium hydroxide (lye) and washed in distilled water.

Now, using the utensil as the cathode and the rotor as the anode, the two elements are attached to a source of D.C. power. If batteries are used, the forming process will take considerably more time than if a generator is available. The anode should be connected to the positive side of the generator and the cathode to the negative. The voltage should be applied and should be slowly increased as the current taken by the forming process decreases. Agitation and bubbles will be noticed as the forming process takes place. The final voltage of the process should be 450 volts

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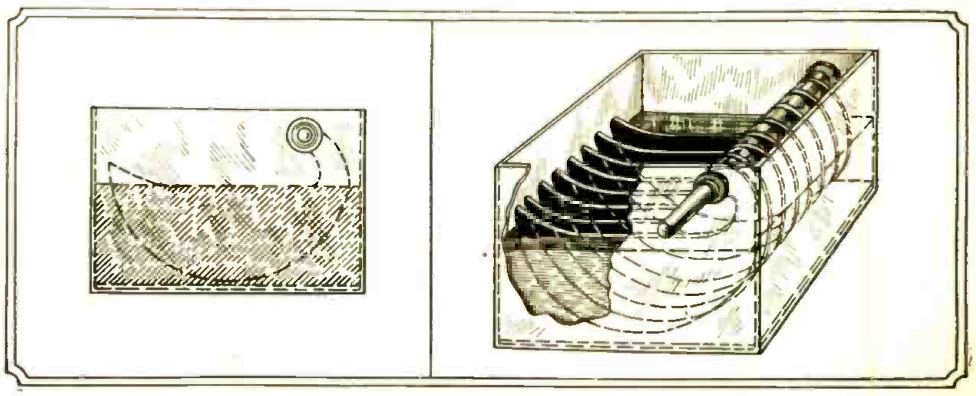

Fig. 3, left. *Observe the position of the plates as they are immersed in the liquid.*
Fig. 4, right. *The complete condenser assembly with all plates immersed.*

An INEXPENSIVE

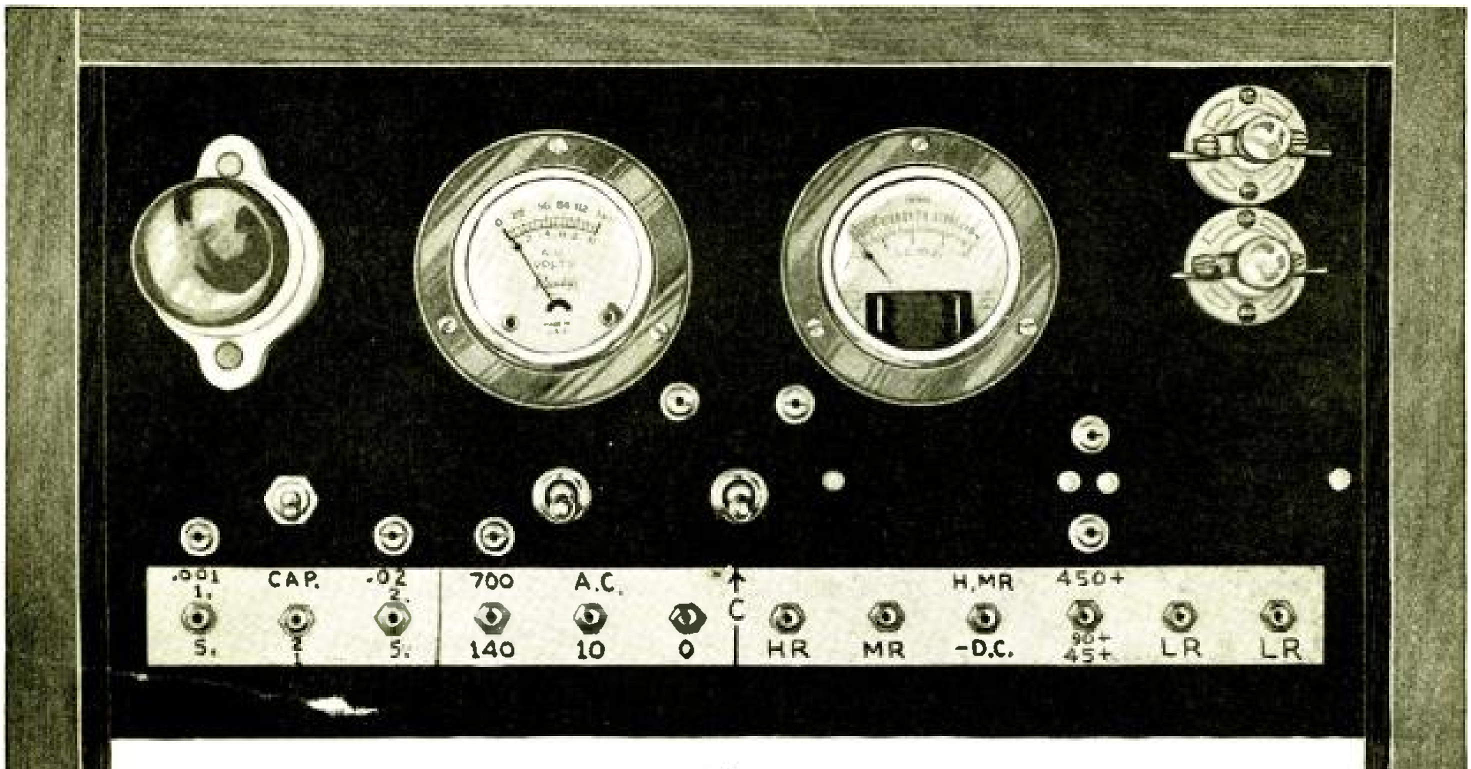

Fig. A

Pictorial layout of a very inexpensive test bench. To eliminate the cost of engraving the panel, a strip of cardboard, marked as indicated above, is used. The large lamp shown at the left, is for the purpose of showing when the power is "on."

THE average Service Man is equipped with a satisfactory set analyzer which is adequate for the major tests encountered in the general run of service work. The writer owns a so-called "portable laboratory" which is supposed to furnish a multitude of tests; still, if you are a busy Service Man, your work bench will soon become one huge messy tangle of wires. One soon comes to the conclusion that fifteen minutes is spent hooking up apparatus necessary to run a one-minute test.

To rectify this condition, a compact test panel, well within the financial means of every Service Man, and flexible enough to cover the range of tests necessary in the shop, has been designed by the author. Fig. A presents such a surprisingly low-cost bench test panel, size 7 x 14 ins., which will take care of practically all specialized testing and which consists of the following: ohmmeters, 0-10,000 and 0-50,000 ohms, low-range ohmmeter; capacity measurement of .001-, .02-, .5-, 1-, and 2-mf. condensers by the substitution method; capacity meter; continuous line-voltage check; high, low, and medium continuity check; voltage scales of 4.5, 90, and 450 for D.C.; voltage scales of 10, 140, and 700 for A.C. All meter ranges brought out to small phone-tip jacks, requiring only two test leads to gain access to any test on the panel.

By HAROLD RIETH

This test panel should prove a valuable asset to the Service Man as a time and labor saver when used in conjunction with the regular analyzer in the shop.

Low-Resistance Check

A very useful, and probably the least expensive, section of the panel is a low-resistance checking unit, which consists of one 2.2- and one 1.25-volt flashlight bulb. The 1.25-volt bulb may be rather difficult to secure, due to the fact that at the present time this bulb is not being used very extensively.

The two bulbs are in parallel and are in series with a 1.5-volt dry cell and phone-tip jacks, which are labeled LR, LR in Fig. 1, and are situated at the extreme right-hand side of the jack strip. There is no switch on this unit and it is possible to use either of the two bulbs by simply tightening the one desired and slightly loosening the remaining one. The 2.2-volt bulb is used in checking resistances between 2 and 9 ohms, which cover the majority of low-resistance tests encountered in service work. With the 2.2-volt bulb tightened and two test leads inserted in the pin jacks marked LR, LR and placed across the primary or secondary of R.F. coils, R.F. chokes, voice coils or any resistance between 2 and 9 ohms, the bulb will either light dimly or fail to light; should the bulb light to full brilliancy, there is evidently a short circuit.

Shorted condenser plates can be located by placing the leads across the condenser and varying the capacity from minimum to maximum, and at any position of the rotor where the plates rub, the bulb will light brightly. It is then not necessary to unsolder the coil which is usually connected across the condenser. By repeating this procedure to each condenser of a gang, the one which is shorted may be easily detected.

The 1.25-volt bulb is used to check resistances between 0 and .5-ohm, such as very low resistance coils, center-tap resistors, etc. This test is ideal for locating high-resistance joints and is used in the same manner as the 2.2-volt bulb.

By noting the intensity of the light which is produced by an unknown resistance when placed under this test and compared with the light which is produced by a known resistance, one may be able to judge with fair accuracy the value of the unknown resistance, providing its value lies within the range of this test. The fact that the resistance of No. 40 copper wire may be placed at one ohm per foot helps in making this comparison.

SERVICE TEST PANEL

Numerous test panels have been described heretofore, but they all have been rather costly. In the panel described by the author, versatility and simplicity have been combined to form a low-cost unit. This panel is especially adaptable for the beginner in radio.

Resistors which are too large to register under this test may be easily checked with the ohmmeter. After checking for short circuits, and the bulb fails to light, it is a wise procedure to test with the ohmmeter to be sure of continuity.

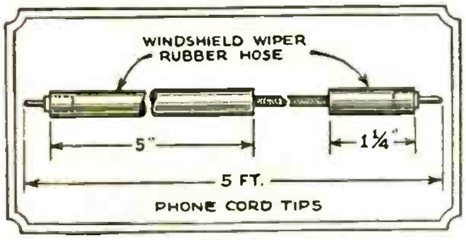

Fig. 3

Detail of the test prod used in the panel.

Condenser Section

At the extreme left-hand end of the jack pin strip, Figs. A and 1, is located the condenser substitution section, consisting of .001-, .02-, and two 1-mf. condensers. Switch S1 is used to place the two 1-mf. condensers in parallel for the 2-mf. The capacity across the .5-, .5-jack pins is .5-mf. resulting from the two 1-mf. condensers being placed in series.

The substitution method is one of the quickest and surest means of locating open condensers, as it does not require the removal of the condenser under test in order to make the test. It is used whenever a receiver hums, oscillates, or is dead, and all the voltages appear to be normal. To each condenser the procedure is as follows: connect the receiver to the aerial and ground in the usual manner and set all controls for reception. Select a capacity on the panel which will correspond to the capacity to be tested and, by means of the test leads, place the panel condenser across the receiver condenser. If normal reception results, the condenser in the chassis is open and should be replaced.

Ohmmeter, D.C. Voltage Scales, High and Medium Continuity Test

The ohmmeter is used to measure values of resistances up to 50,000 ohms, also providing medium- and high-resistance continuity tests. The D.C. voltage scales are instrumental in tracing voltages through the circuit from power pack to their destination in cases of shorts and opens.

This unit of the panel has for its nucleus a 4.5-volt, 10,000-ohm direct-reading resistance meter. The negative post of this meter is the common terminal for the 10,000 and 50,000 ohmmeter, and the negative post for all D.C. scales. Multiplier resistors R4 and R5 (Fig. 1) are placed in series with the positive terminal of the meter to increase the original 4.5-volt scale to 90 and 450 volts, respectively. Resistor R3 is placed in series with the 22.5-volt "C" battery lead to increase the ohmmeter range from 10,000 to 50,000 ohms; readings being taken on the 10,000-ohm scale and multiplied by 5. The range may be further increased to 100,000 ohms by placing another 22.5-volt "C" battery and resistor of suitable value in series with the original 22.5-volt "C" battery and adding another jack pin to the panel.

It is advisable, although not shown in the schematic, to place a 40-ohm rheostat in series with the +22.5-volt "C" Battery lead to shift the ohmmeter to 0, thereby compensating for any error due to the variation of the "C" battery voltage.

A.C. Voltage Scales, Capacity Meter

The A.C. unit of the panel consists of a double-range voltmeter of 0-10-140 volts, R2 and R1 being multiplier resistors which increase the 10-volt scale to 140 and 700 volts, respectively. The 10-volt scale is used to check the filament voltages from power transformers. This scale may also be used as an output meter by connecting it across the voice coil of a dynamic speaker. The 700-volt scale is helpful in locating unbalanced secondaries of power transformers. When the switches S2 and S3 are closed, the line voltage may be read directly on the 140-volt scales.

By inserting leads into jacks C, C, which are located between the two meters, and applying to condensers having a capacity of .1-mf. or larger (with the panel switch S3 closed) a reading will be obtained on the 140-volt scale. By jotting down the readings for various known capacities and using this table in collaboration with the meter, a capacity meter, which is adequate for service work when dealing with condensers of this range is obtained. The ohmmeter should always be used first to test for high-resistance leaks before subjecting condensers to the capacity test.

When the switches S2 and S3 are closed, and leads plugged into the 140-scale jacks, 110 volts A.C., which may be used occasionally in service work, is secured. In the upper left-hand corner of the panel, a 110-volt porcelain receptacle is located for use either as a pilot light, indicating that A.C. is being supplied to the meter and no other tests can be made until switches are opened, or it may be used to plug in any apparatus requiring 110 volts A.C.

Multiplier Resistors

The values of resistors R1, R2, R3, R4, and R5 depend solely upon the meters se-

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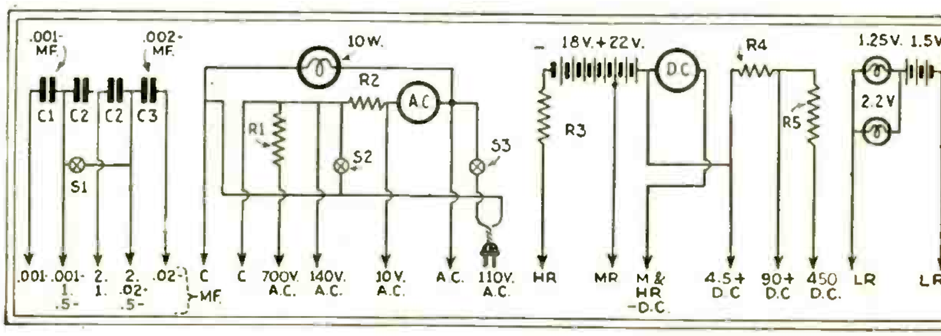

Fig. 1

Schematic circuit of the test panel. Its very simplicity can easily be appreciated by studying this diagram. The markings of the posts on this diagram correspond to those of Fig. A. The wiring is simple, and a beginner should have no difficulty in following the description in the text. The capacity of condensers C1, .001-mf.; of C2, .1-mf. each; and C3, .02-mf.

SHORT-CUTS in RADIO SERVICE

By WALTER L. LYONS

(Prize Award)

REPAIRING CONES

THE Service Man will now and then have a set to repair in which the cone of the speaker, or even the voice coil, has been damaged. In many cases, he may find that he cannot get the cone without sending to the manufacturer. Or the manufacturer may insist on doing the repair job himself. Either situation means loss of time and profit, and possibly a dissatisfied client. Yet a bit of ingenuity will get around many of these service calls if the repairman will follow the procedure outlined below.

Doubtless, many Service Men have tried to lay out patterns for cones, only to find on assembling that the cone was a bit larger or smaller in some dimension, rendering it useless. The method as outlined will reproduce the cone exactly, if it has no corrugations or other features impossible to produce with a sheet of flat paper, scissors and cement.

Paper of the same quality as that used in the cone may be bought at the stationery store in the size 2 by 3 feet for twenty cents or less. In cones ten inches or larger of the dynamic type, the use of a heavier paper tends to accentuate the low frequencies. For smaller sized dynamic cones, the use of heavier paper merely means more difficulty in handling.

$10 FOR PRIZE SERVICE WRINKLE

Previous experience has indicated that many Service Men, during their daily work, have run across some very excellent Wrinkles, which would be of great interest to their fellow Service Men.

As an incentive toward obtaining information of this type, RADIO-CRAFT will pay $10.00 to the Service Man submitting the best all-around Radio Service Wrinkle each month. All checks are mailed upon publication.

The judges are the editors of RADIO-CRAFT, and their decisions are final. No unused manuscripts can be returned.

Follow these simple rules: Write, or preferably type, on one side of the sheet, giving a clear description of the best Radio Service Wrinkle you know of. Simple sketches in free-hand are satisfactory, as long as they explain the idea. You may send in as many Wrinkles as you please. Everyone is eligible for the prize except employees of RADIO-CRAFT and their families.

The contest closes the 15th of every month, by which time all the Wrinkles must be received for the next month.

Send all contributions to the Editor, Service Wrinkles, c-o RADIO-CRAFT, 98 Park Place, New York City.

The cone which is to be duplicated should be separated from the rest of the speaker as intact as possible. A sharp knife or razor blade will usually suffice to open the joint between the cone and the leatherette rim which usually holds it to the frame; this is illustrated in Fig. 1. A bit of ether applied with a small brush will help to soften joints in which the "dope" has become too crusty for the knife to cut. It will probably be necessary to remove the fiber "spiders" which center the voice coil around the field pole, as shown in Fig. 2. Note carefully their positions on the coil by a scratch or measurement, as well as the point of attachment of the coil itself to the small end of the cone. The seam of the cone must be opened before it can be stretched out flat to make a pattern. Before this is done, however, the seam must be "pinholed."

That is, in order to reassemble the new cone pattern accurately, a small pinhole is made in each end of the seam and a third midway between them, all, of course, on the seam as shown in Fig. 3. The seam may now be opened, care being taken not to mutilate either the edges of the seam or the pinholes. Use a bit of ether if the seam proves obstinate.

When spread out absolutely flat, the cone now looks as shown in Fig. 3. Usually, a small flange on the cone (used to fasten on the voice coil) is so saturated with "dope," that any attempt to flatten it will result in cracking off the flange, which should be allowed to stick up.

Marking the New Paper

The new sheet of paper should be placed on a flat wooden surface and the old cone placed on top of the sheet, and both flattened out by the application of heavy objects such as flatirons, plate glass, etc. There are now six pinholes, 3 in each edge. Through each of these, pass a thumb tack straight down through the new sheet and into the wood. With a sharp, soft pencil, the outlines of the cone may be traced, supplying, where necessary, any of the outline obliterated by the razor blade.

The small inner circle should be traced *very carefully* as the fitting of the voice coil depends on its accuracy. In addition, a third circle of a radius about 3/16-in. less is traced by a compass inside this one, in order to make the flange, if one is required. When the outline is complete, the thumb tacks are

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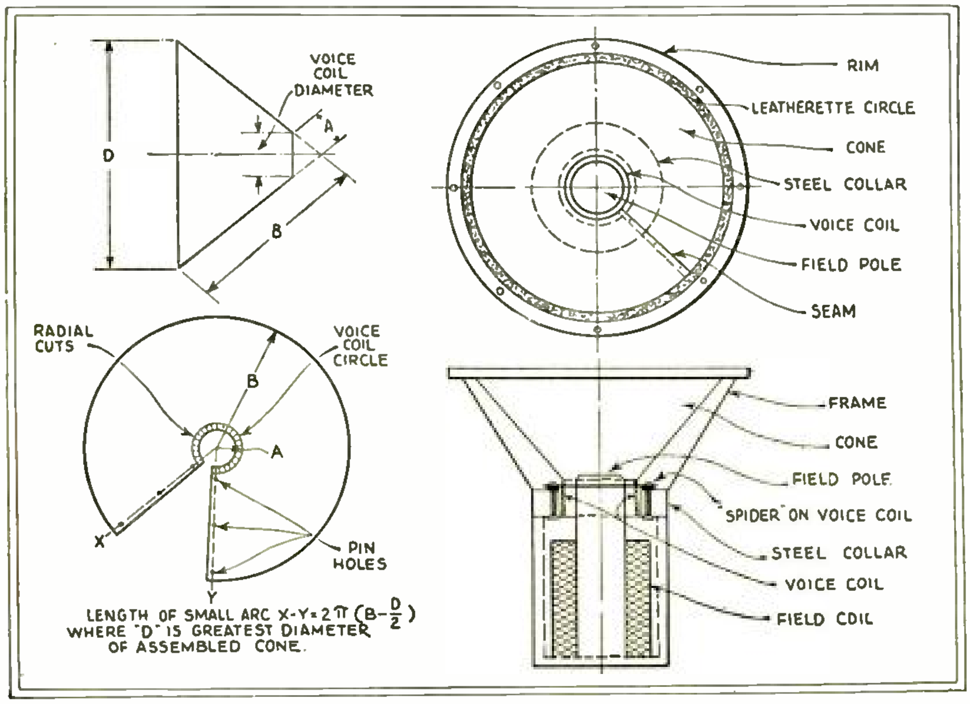

Fig. 1, upper right. *The old cone is cut from the leatherette which holds it to the frame.*

Fig. 2, lower right. *Cross-section of the speaker showing the location of the spider.*

Fig. 3, left. *The old cone flattened out which may be used as a template. The upper sketch aids in illustrating how the cone openings may be calculated.*

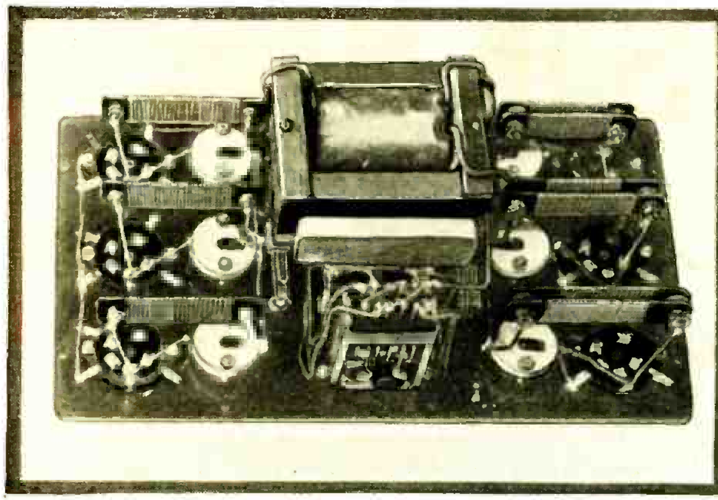

Fig. D. *Internal view of the short-checker and preheater.*

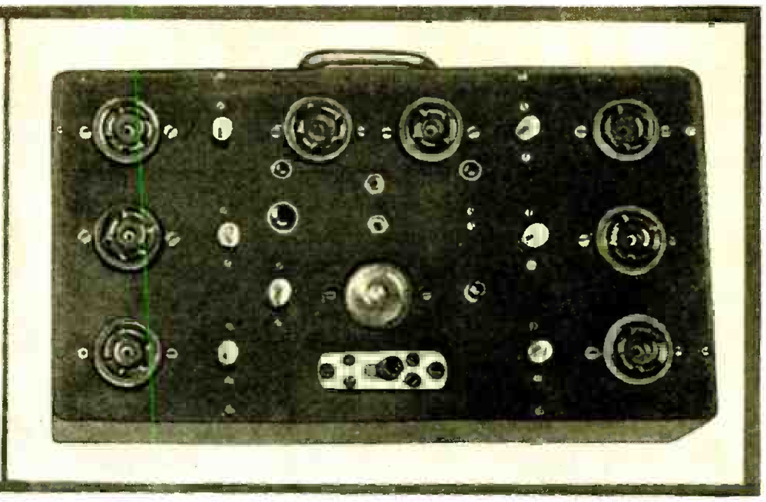

Fig. C. *Outside view of the tester described by the author.*

"SHORT"-CHECKERS

(PART II)

A description of a short-checker and preheater suitable for radio servicing.

By JESSE TILLETT

ALL that has been said about the type and characteristics of the neon lamp and the use of the series condenser in discussing Fig. 4 applies with equal force to Fig. 5 and will not be repeated.

The circuit in Fig. 5 was built up in a 6½-in. x 11½-in. x 3½-in. box for counter or bench use and can be built up separately or in combination with a regular tube tester as desired. Figs. C and D illustrate the exterior and back-of-panel views of this checker. It will be noticed that the short-checking arrangement is the same as used in Fig. 4. Instead of using two push-type switches, however, as in Fig. 4, the switch used, and designated as S1, is a Federal No. 1424 anti-capacity switch.

This switch was originally a four-pole, double-throw affair with an "off" position in the center, and was altered to the extent of bending four of the round contact members so as to make contact with the four flat members in the center position. When thrown to the left, two of these four contacts are broken and two others made in their places and the same is true when the switch is thrown to the right; thus making, in effect, a pair of double-pole double-throw switches actuated by a single lever and constituting essentially the same arrangement as is used in Fig. 4.

Two so-called "clearance sockets" are shown in the center of the diagram and these are used in conjunction with S1 for checking tubes for all shorts, the remaining six sockets being arranged to preheat three of each of the 2.5-volt and 6.3-volt cathode-type tubes, and check them for heater continuity or intermittent heaters.

Switch S2 is a single-pole double-throw affair for checking filament continuity on four-prong and five-prong filament-type tubes. Normally, it places a jumper across the filament connections for the usual short tests but, when pressed, joins one side of the filament to the plate for a filament continuity check using the same neon lamp for this purpose as for the short check.

Switch S3 is the A.C. line switch and needs no further comment.

The Transformer

The filament transformer specified for this circuit has a 10.5-volt secondary tapped at 4.5 volts. These values are based on a line voltage of 110. The 4.5-volt winding supplies the 2.5-volt tubes through 2-ohm, 10-watt resistors shunted by Mazda "41" 2.5-volt dial lights, designated A, B and C in Fig. 5, and the voltage drop across this combination is approximately 2¼ volts, leaving a like voltage drop across the heater of the tube. The 10.5-volt tap supplies the 6.3-volt tubes through 35-ohm, 2-watt resistors, each shunted by a Mazda "40" 6-volt dial light, designated E, F and G in Fig. 5, and the 10½ volts are approximately divided between the dial-light-resistor combination

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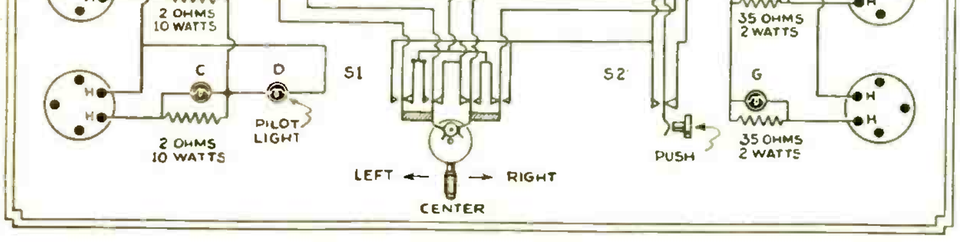


Fig. 5

Diagram of connections of the completed short-checker and preheater. An anti-capacity switch is used to test for shorts between elements of the tube. This diagram should be compared with that published in the February issue of RADIO-CRAFT, *as the only change is in the switch.*

Operating Notes

The Analysis of Radio Receiver Symptoms

By BERTRAM M. FREED

DURING the past season, a great number of new radio receivers made their appearance. Almost every reputable manufacturer released at least one receiver employing the superheterodyne circuit, variable-mu and pentode tubes, tone control and automatic volume-control. Although these advanced features resulted in far better radio receivers, their use brought their attendant difficulties. On the other hand, many problems have arisen because of certain common failures of component parts.

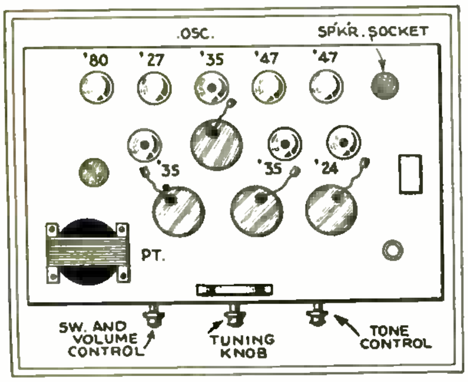


Fig. 1
Socket arrangement of the Colonial 47 receiver. Three variable-mu tubes are used.

Colonial Model 47

In the Colonial Model 47, a superheterodyne receiver, the condition of unstable operation accompanied with the complaint of poor tone at moderate volume has been found to be caused by the misplacement of the screen-grid tubes. Three variable-mu type '35 tubes are used in this receiver as well as one type '24 as a second-detector. When a '35 is placed in the second-detector stage, the above complaint will ensue. This tube will not function properly as a detector in a T.R.F. receiver, or second-detector in a superheterodyne, because of its electrical characteristics. The socket arrangement of the Colonial 47 is illustrated in Fig. 1.

Reception on this model is often marred by hum, slight in some cases, and in others quite disturbing. This condition is not caused by any defective part. Its presence can only be attributable to poor mechanical design, resulting in interstage coupling.

Stromberg-Carlson Models 25, 26

Some time ago, an interesting problem was presented by a Stromberg-Carlson Model 25, 26 receiver. The complaint was "intermittent reception." After the set had been in use for a few minutes, it would suddenly go "dead." When the line switch was snapped off and then on again, reception would be resumed. On other occasions, the receiver would stop and start up again without anyone having disturbed it in the least. A thorough check disclosed a lack of plate voltage on the screen-grid detector. The chassis was taken down in an attempt to locate the trouble.

The primary of the input push-pull audio transformer was tested but this winding proved O. K. (Besides, if the primary had been open, a voltage reading would have been obtained at the detector plate, because of the 250,000-ohm carbon resistor shunted across the winding as a loading device, since the plate impedance of the screen-grid tube as a detector is high.) The 40,000-ohm carbon resistor used to reduce the high voltage to that required by the detector, was suspected, but this also proved correct when a resistance measurement was made.

A "short" test made from detector plate to chassis produced only a very high resistance effect, apparently pointing to no trouble on this point. With the receiver turned on, voltage measurements were made from the "B+" side of the primary. This showed 20 volts, but the reading obtained from the high "B+" terminal of the voltage divider,

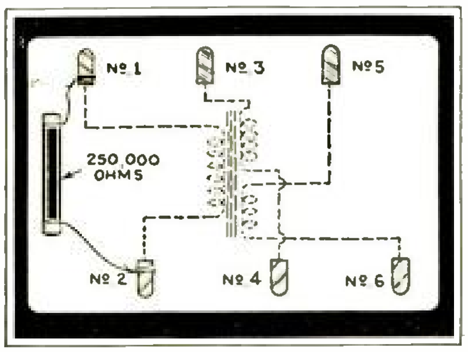


Fig. 2
The primary of the transformer shorted to ground under load, causing poor reception.

compared with that on the voltage chart for this receiver, showed a discrepancy of about 40 volts. The 40,000-ohm detector series-resistor was unsoldered from the lug on the condenser block and the voltage jumped to slightly above normal.

This lead to the conclusion that some part of the detector-plate circuit was shorting to the chassis or "B—," even though the "short" test did not indicate the defect. The resistor was replaced and the lead to the "B+" terminal of the input transformer, marked No. 1 in Fig. 2, was disconnected. The correct voltage was obtained at the wire; but as soon as it was placed back on the terminal, the voltage dropped to 20. These results pointed either to a shorting primary, or a leaky or otherwise faulty bypass condenser (.0001-mf.) located within the R.F. choke housing.

To determine the guilty member, the lead from terminal No. 2 on the transformer was removed and the voltage found at this terminal was zero. To further check the unit, the primary was entirely disconnected, but the 250,000-ohm shunt resistor was left in the circuit. Although the required 200 volts was not impressed on the detector plate, a sufficient reading was obtained to warrant the assumption that the primary of the transformer shorted to either the core or the casing, in some way, *under load.* Similar failures in subsequent receivers of the same model were easily detected and a repair speedily effected by replacement of the transformer.

Many cases of noisy reception have been reported on the Stromberg-Carlson Models 25, 26. In most instances, the trouble has been traced to a noisy primary of the push-pull input A.F. transformer. This condition will evidence itself even with the detector tube removed. It seems that the unusually large primary winding, so made to match the high impedance of the screen-grid detector plate, has resulted in many breakdowns. Perhaps the best method for determining positively whether the primary is at fault is to disconnect the primary and use the 250,000-ohm shunt resistor in conjunction with a .06- or .1-mf. condenser connected as shown in Fig. 3. It is not advisable that this procedure be used as a permanent repair as the quality of reproduction will suffer considerably.

A frequent cause for an inoperative Stromberg-Carlson Model 25, 26 lies with the bolt that protrudes from the chassis, which bites into a section of the voltage divider. This bolt should be cut down or replaced with one that is shorter.

Atwater Kent Models 83, 85

Often, the complaint of poor tone, low volume, and little response when the tone

(*Continued on page 565*)

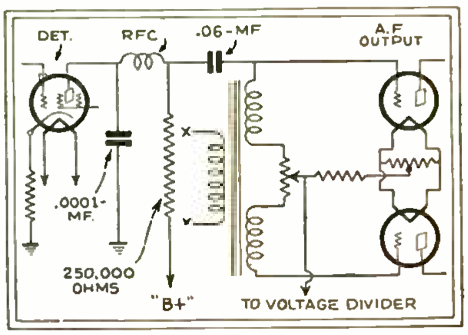


Fig. 3
Determining faulty transformers by using the circuit as an impedance-coupled stage.

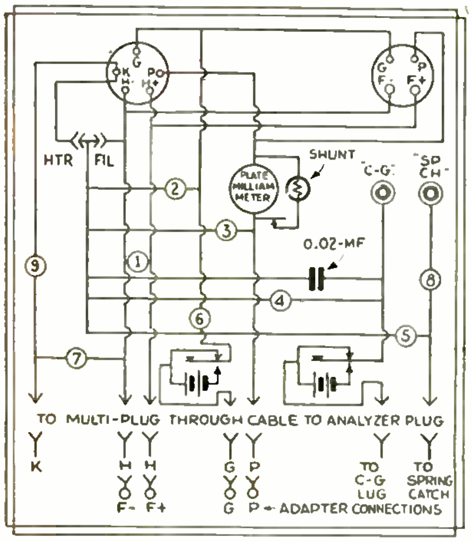


Fig. 4

The power unit of the Multi-Meter.

Dissecting a SET TESTER

(PART II)

In this, the second of a series of articles, the author discusses the set analyzer, which is an integral part of a modern set tester.

By FLOYD FAUSETT*

A RADIO set analyzer is essentially an extension of the circuits which normally terminate at a radio tube socket, providing convenient means for connecting a meter, or meters, across the circuits for potential measurements, or in series with certain of the circuits for current measurements.

The basic mechanical elements consist of: (1), an analyzing plug, properly connected with; (2), cabled conductors to the terminals of; (3), a tube socket, or sockets, on the panel of the analyzer, and with; (4), the necessary analyzer switching arrangement for connecting; (5), a meter, or meters, across or in series with the cable circuits for making potential or current measurements.

The various commercial analyzing testers differ only in refinements of these basic elements, the main differences being in the switching arrangement, and in the meters employed.

Although the radio analyzer is probably the basic and most simple of all practical radio testing equipment, the flexibility of its applications and the value of its indications can be realized only by radio men who are familiar with radio testing principles.

Circuit Subdivisions

As the fundamental operating characteristics are practically the same for all radio sets, for the purpose of analysis the circuits of the radio receiver fall into two classifications, namely: (1), the tube-socket circuits which are supplied with potentials from the power pack and may always be subjected to tube-socket analysis; and (2), the input (pickup) and the output (audible reproducer) circuits, which may or may not be directly connected to the receiver's power pack, and may require the use of some method of testing other than that afforded by the tube-socket analysis.

The electrical characteristics of the circuits which are not amenable to tube-socket analysis may be determined by their reaction to broadcast or oscillator signals with the radio set in operation. Defects in these circuits may be located by means of "continuity tests."

If properly connected, each filament, plate, grid, screen-grid or space-charge-grid, and cathode circuit of a radio receiver terminates at a tube socket. In other words, the set is designed for its tubes which are the heart of radio circuits; the tube circuits constitute the arteries, veins and nerves, centering at the tube sockets at which most of the needed information as to the operating characteristics of a receiver may be ascertained with a good analyzer.

Design Considerations

In the design of the Model AAA-1 Diagnometer, for example, the value of complete analytical functions was fully appreciated, and every advanced idea of practical value was incorporated in an effort to provide analyzing facilities of unsurpassed merit.

For instance, the Diagnometer was the first testing device to introduce the use of an "analyzing plug" equipped with a snap-catch arrangement for engaging the adapter for preventing its becoming separated from the plug in radio tube-sockets which have tight-fitting contacts. The analyzing plug utilized with the "AAA-1" has a UY base, as most sockets in the newer types of radios are of the UY or 5-prong type. A 4-prong adapter is furnished as part of the equipment for analysis in rectifier and other type UX sockets. The control-grid lug is attached to the analyzer plug by a flexible lead which enables the operator to complete the control-grid connections of screen-grid sockets without difficulty in any type of radio receiver employing any size of screen-grid tubes.

Heavy wire is used in the cabling for the filament and heater circuits so as to minimize the potential drop occasioned by the heavier currents involved, and high-voltage insulation is employed for all conductors. All wiring cables are boiled in paraffin to prevent the absorption of moisture in humid climates with resultant insulation leakages.

(Continued on page 565)

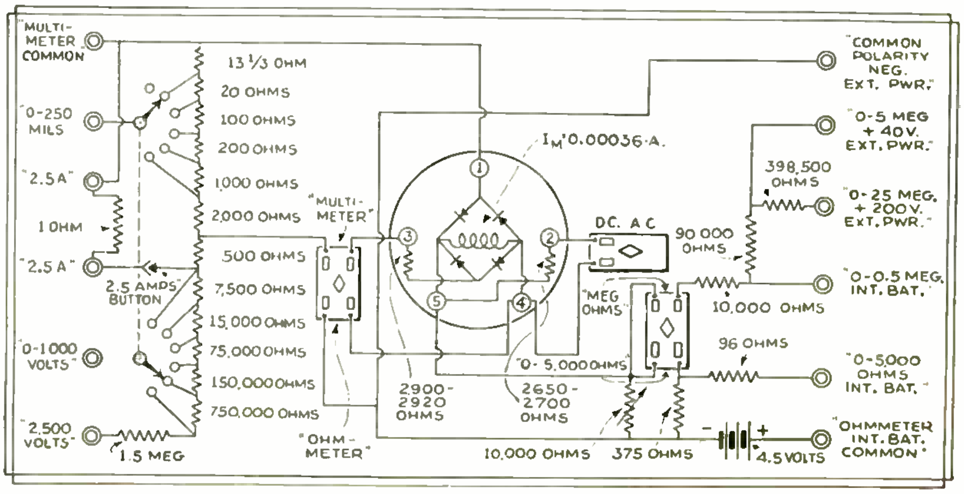


Fig. 3

Complete schematic, showing all values, of the Multi-Meter. Note the bridge arrangement of the rectifiers used for obtaining a high resistance A.C. meter.

*Chief Engineer, Supreme Instruments Corp.

The Service Man's Forum

Where His Findings May Benefit Other Radio Technicians

A SELF-MADE SERVICE MAN

Editor, Radio-Craft:

I think it no more than right that I should write and congratulate you on printing the best magazine for Service Men and experimenters in the world.

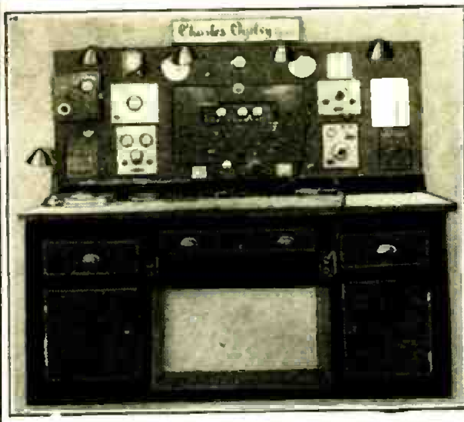
I read with interest every month all the "dope" printed in your magazine, and like the "Radio Craftsman's" own page better than any of the other features, as I get a big kick out of some of the differences of opinion which are expressed there. I am just one of these country boys who have "picked up" radio, and never took any of the courses, or any thing like that, and am of course one of those guys which the educated birds are all taking a wallop at, but I can still say and prove that there has never been a set in my shop for repair which has not gone out in good condition and given good satisfaction. And another thing, I have made a nice profit fixing up sets which have been "repaired" in the shops of some of these wise guys. So it seems to me that practical knowledge is just as good, and sometimes a lot better than a lot of theory gleaned from a correspondence course, and I offer as evidence any set I ever worked on.

There is a lot of money to be made by Service Men, right now while times are hard, in reconstructing old sets, particularly battery-operated sets, to incorporate the new low-drain tubes. If the boys will re-design the sets right in the first place, and leave out a lot of chokes and condensers that are really not needed, they will find that they are enabled to completely re-build a six-tube set for very little and then make a profit selling the customer the new tubes he will need. I have just completed a job of rebuilding one of these sets, and I charged the customer $4.30 for my time and material, and sold him a new set of tubes. The set is giving complete satisfaction, and I assure you that I made money on the deal. This set contains only one filter condenser, which bypassed the high-voltage lead, and one double bypass condenser of .25-mf. capacity, to bypass the two screen-grid leads, and there is absolutely NO radio-frequency choke any where in the set. It is merely a matter of proper shielding and placement of parts, and I used no complicated formula for figuring all that out either. Give the self-made Service Man a break! There are probably as many set butchers who are graduates of some school as there are of us uneducated birds.

Would be pleased to hear from any of the boys at any time, and believe in the principle of trading information. Will gladly help any one, to the best of my ability, in methods used for rebuilding old sets as mentioned above.

O. D. Elder,
Spring Valley, Wyoming,

P.S. The flying Serviceman has us all beat. How does he get that way? O.D.E.



"We have possibly the finest equipped service laboratory in Canada," writes Mr. Leo La Pointe, of Charles Ogilvy, Ltd., Ottawa, Can. This test panel, built around a Diagnometer, includes equipment for nearly every measurement; several types of oscillators also are available.

EDUCATING SERVICE MEN

Editor, Radio-Craft:

I have found in my experience as service technician and service manager that there is a decided lack of proper education among Service Men and employees of many manufacturers and distributors.

Anything which can be done to advance education of both Service Men and public will be a great boon to the industry. The work of the O.R.S.M.A. and the local service organizations is to be highly commended. I may mention a few instances where the manufacturers would have saved money had dealers and Service Men been properly informed.

About a year and a half ago, there was a great deal of discussion in Salt Lake City concerning poor reception in Ely, Nevada. Our company was manufacturing and distributing Electra Radio Sets. Customers in Ely complained that they could get no reception (about 300 miles distant). Service Men of that vicinity agreed among themselves that the condition was due to copper deposits in the mountains and gave up the problem.

I made an unofficial trip through Nevada stopping at Ely. A few hours of investigation revealed the fact that battery-operated sets performed very well during the day. A line-voltage test indicated an average of 80 to 90 volts A.C. until about 7:00 o'clock in the evening, then the voltage gradually rose to 125 at 8:00 o'clock. Any Service Man should know that the lack of daytime reception was due to this low voltage and not to mineral deposits.

A dealer handling several popular makes of receivers was advertising that the set was all wired and ready for television to be plugged in as soon as a television receiver was available. He and his "Service Men" pointed with pride to two pin-jacks on the rear of the chassis into which television was to be plugged. I wondered if his Service Men knew that these plugs were in reality, intended for a phonograph connection?

I recently met a Service Man in his shop who had just rewound an R.F. transformer. He asked if I knew why the set did not have normal value. I picked up a screw driver and adjusted the neutralizing condensers, the set at once delivering full volume. He was very pleased to learn the trick, always having wondered what the purpose of these adjustments was.

I believe that the real Service Men will be found in their attics, basements, or garages, doing good work for which they receive good money because the average dealer does not yet realize that a good Service Man is worth more than $18.00 or $20.00 a week.

Francis M. McKinney, E.E.
831 *Lincoln St., Denver, Colorado.*

MR. FREED'S PAGE

Editor, Radio-Craft:

Reading page 286 of the November issue of Radio-Craft, written by Mr. Bertram M. Freed, which contains information on servicing problems, forcefully emphasized the great help that Radio-Craft is to the Service Man.

Only one of the complaints, found by Mr. Freed in one of the sets he mentions, has been found in this part of the country by the writer, who happens to specialize in the make of set referred to; all of which goes to show how various parts break down in the same type of sets in different parts of the country.

Mr. Freed's findings will be of great help in the future when the time comes to locate the unusual troubles; I say unusual, since the faults found and discussed by Mr. Freed are uncommon ones.

I have just received my copy of "Radio Set Analyzers" and find it unusually full of real information. Let's have some more on kindred subjects.

J. A. Thomas,
216 *Ashley Ave., Charleston, S. C.*

FINDING GRID BIAS

BIAS resistors usually are connected from the cathode or the filament center tap of a tube to the chassis of the receiver or to the negative of the plate current supply, when the bias is obtained by the drop due to the plate current of the tube, according to Jesse Marsten, Chief Engineer of International Resistance Company. The resistance value should be equal to one thousand times the rated negative grid bias of the tube in volts, divided by the rated plate current in milliamperes. If more than one tube derives its bias from the same resistor, find the proper resistor for one tube by the formula just given and divide the resistance value so found by the number of tubes biased by this resistor.

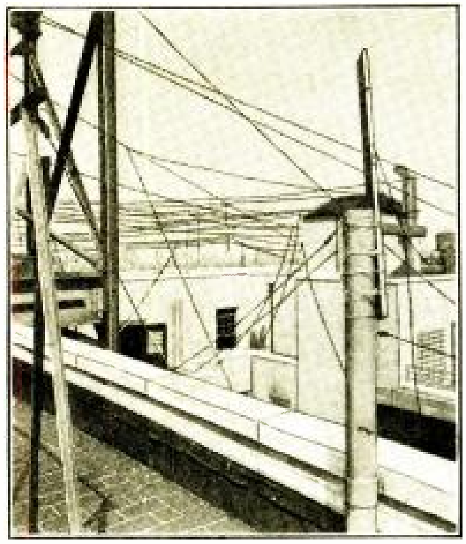


Fig. B
The pipe which caused a "shower of plaster."

RADIO SERVICE *and the* ELECTRIC CODE

(PART II)

In this part, typical big-city aerials are described.

By GUS JACOBSON and L. LAKS

FURTHER study of the National Electrical Code in its relation to the radio Service Man reveals that the insurance authorities attach little importance to aerials. In Chapter 37 of the Code, under the title of "Radio Equipment," separation from power lines is requested, joints in the aerial span are required to be soldered unless an approved solderless splicing device is used, and work is to be done in a neat and workmanlike manner.

The third rule is rather general and leaves much to the aerial installer's conception of what constitutes a "neat and workmanlike manner." Free aerial-installation with radio-receiver purchases, complete installations for $2.00, and aerials installed by radio-set owners who have neither the mechanical ability nor the necessary tools to make a good installation have brought present conditions to the state where good work is the exception rather than the rule.

Legislation instigated by fire authorities, after firemen, or persons escaping from fires over roofs, have become entangled in or injured by trailing aerials and lead-in wires, or by property owners who have suffered property damage from these "hurry-up" installations, is pending before a number of law-making bodies and prohibits entirely or provides certain minimum requirements for aerials strung across roofs.

Fig. A shows a typical roof-line in New York City. Note the lead-in wires hanging in front of the windows at A,B,C, and D. At E, an effort was made to keep clear of the window. A clean lead job would be simply to fasten the wire to the wall outside the edge of the fire escape, with rawl plugs and knobs.

At first glance, there seems little connection between the manner of installing an aerial on a roof, and the plaster ceilings of the rooms in the apartments below. Or between a "hurry-up" job on any aerial, and a set bought on the instalment plan being returned to the dealer. Here is a case, however, in which the facts can be personally vouched for by the writers.

A Shower of Plaster

Four years ago, one of the writers was called in to locate a short circuit in an apartment house which was owned by a real estate firm for whom he did maintenance and contract electrical work. While upon a stepladder opening a fixture splice, he saw a crack suddenly develop in the ceiling plaster and spread across the room, the sections of plaster on either side of the crack sagging down toward the floor.

Not wishing to be struck on the head with a lump of plaster, he mounted the stepladder as high as possible and remained there, holding up with both hands the section of ceiling over himself, while pieces of plaster dropped from the ceiling to the floor. The crash of the falling plaster brought aid and the remaining plaster was removed in small sections.

The room in question was a bedroom. Had this plaster shower occurred at night with some person asleep, serious injuries might have resulted—possibly fatal.

A hurried examination of all the ceilings in the rooms below, showed most of these to be loose and it was found necessary to take these down and replaster. Oil paint, instead of kalsomine, having been used upon these ceilings, the water leaks causing this condition had not become noticeable.

On the roof immediately above, twelve aerials were found fastened to a vent pipe coming up through the roof. This had originally been braced with galvanized guy-wires, but these guy wires had been painstakingly cut by someone installing an aerial, to prevent contact with his lead-in wire.

The pull of these twelve wires against the pipe had caused the latter to shift, where it came through the roof, and a leak resulted, permitting the rain to enter and weaken the ceilings.

When it was found that similar conditions existed upon most of the roofs of their buildings, the owners ordered all outside aerials removed from all their buildings and no further installations of aerials permitted. This order affected over eleven thousand apartments and the writers have personal knowledge that many of these tenants, denied the use of outside aerials, became dissatisfied with indoor aerial reception and refused to pay the balance of the

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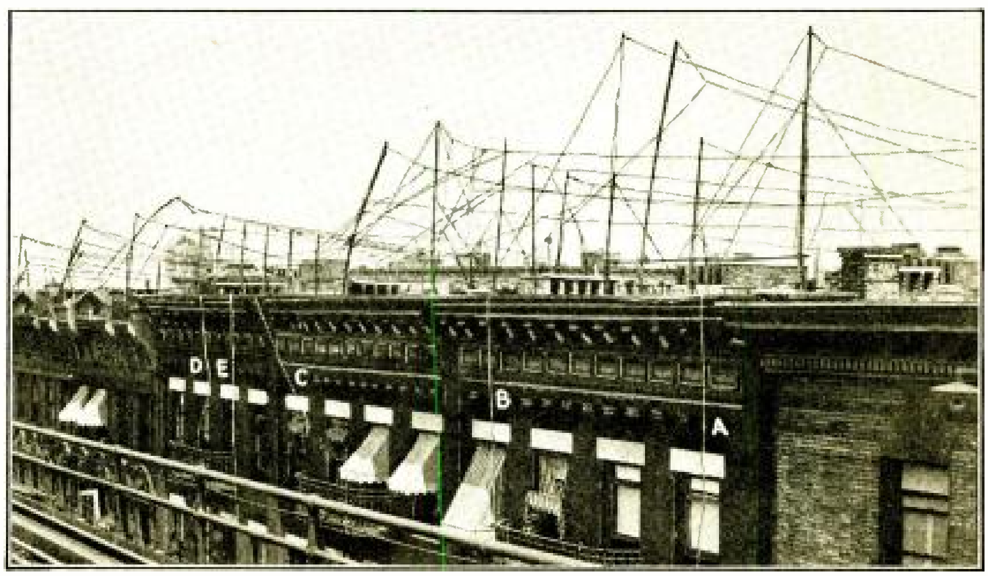


Fig. A
A typical sky-line of New York. Lead-ins A, B, C, and D run directly in front of the windows, not only marring the appearance of the buildings but actually causing a fire hazard where they run in front of fire escapes.

ZENITH MODEL 103 14-TUBE "HYPERHETERODYNE" SUPERHET.

(With Automatic Tuning and Automatic Volume-Control)

Numerous features of paramount interest to the radio Service Man are exemplified in the new Zenith 14-tube receiver, manufactured by Zenith Radio Corp., Chicago, Ill.

There are two types of "Model 103" chasses. Those of serial number 450,450 and below, incorporate the main circuit shown in this Data Sheet; those above this number are referred to as the "audio volume-control" type, and are distinguished by the type of manual volume-control. The former employ a manual volume-control potentiometer R8 in the cathode lead of the A.V.C. tube V12, with the result that the visual tuning meter action is decreased as the volume is lowered. In the latter, resistor R8 is replaced by two fixed units, R8A and R8B, and manual volume-control is obtained in the audio circuit by connecting the two sections of a dual-type potentiometer RA-RB (Zenith Part No. 63-213) across the secondary of T1, and connecting the control-grid leads of V8 and V9 to the twin contact-arms of the unit, as shown at the lower right of the main diagram. Thus, the A.V.C. system operates independently of the manual volume-control.

Normal operating characteristics are as follows: Filament potential, V1 to V9, 2.2 volts; V10, V11, V12, 2.3 volts; V13, 5 volts. Plate potential, V1, V3, V5, V6, V7, 185 volts; V2, 200 volts; V4, 80 volts; V8, V9, 165 volts; V10, V11, 240 volts; V12, 30 volts; V13, 350 volts. Control-grid potential (negative), V1, 9 volts; V2, 3.9 volts; V3, V4, V7, V8, V9, V13, zero; V5, V6, 4 volts; V10, V11, 48 volts; V12, 0.4-volt. Cathode potential (positive), V1, V2, V4, V5, V6, V10, V11, V12, V13, zero; V3, 7 volts; V7, 17.5 volts; V8, V9, 12.5 volts. Plate current, V1, 2.5 ma.; V2, V5, V8, V9, 3 ma.; V3, 0.25-ma.; V4, 7 ma.; V6, 2 ma.; V7, 0.5-ma.; V10, V11, 36 ma.; V12, zero; V13, 70 ma. (per plate). Screen-grid potential, V1, 80 volts; V2, 84 volts; V3, 70 volts; V4, V7, V8, V9, V10, V11, V13, zero; V5, V6, 90 volts; V12, 45 volts. These readings were taken on a Weston Model 566, Type 3, set tester. The manual volume-control was set at maximum, antenna and ground were disconnected, and a line voltage of 112 volts used.

The constants of the parts used in the Model 103 receiver are as follows: Resistors R1, R2, R5, R6, 1,400 ohms; R3, R9, 25,000 ohms; R4, 1. megohm; R7, 5,000 ohms; R8, R10, 2,000 ohms; R11, tone control; R12, R13, 3 megohms; R14, R15, 400,000 ohms; R16, R17, 8,000 ohms; R18, 5,000 ohms; R19, R20, 3,000 ohms; R21, 750 ohms.

Condensers C1, C2, C3, C4 and tuning units, shunted by trimmers; C5, C6, C7, I.F. trimmers; C8, "padding" condenser; C9, C12, C13, C17, C18, C21, C22, C23, C24, C28, 0.1-mf.; C10, C11, .0001-mf.; C14, .00005-mf.; C15, C16, .001-mf.; C20, .006-mf.; C25, C26, 8 mf.; C27, 6 mf.

Since each chassis is carefully balanced at the factory on a crystal-controlled oscillator whose temperature is accurately regulated, they seldom require readjustment. However, in the event that a part of the R.F. circuit has been changed or the phasing adjustments shifted by mishandling, the chassis may be realigned as follows:

A test oscillator will give more accurate results and is, therefore, recommended in preference to the use of a broadcast signal; the frequency range should be 550 to 1,500 kc., with an adjustment at 175 kc. for I.F. circuits. *An output meter is not required,* since the tuning meter on the set is connected to the I.F. stages in such a way that it shows a variation during adjustment of any R.F. or I.F. circuit of the set. It is only necessary to watch the tuning meter for greatest swing to the right when adjusting the R.F. and I.F. trimmer condensers.

When the trimmers have been resonated, set the dial to 550 kc. and tune the oscillator until it is heard clearly in the reproducer; of course, this may be done by tuning to a station at or near 550 kc. Turn the oscillator padding condenser (C8) screw for greatest swing (to the right) of the V.I. meter, while rocking the dial back and forth, "across the signal"; the position of C8, at the left of the chassis, is indicated in the illustration of the parts layout.

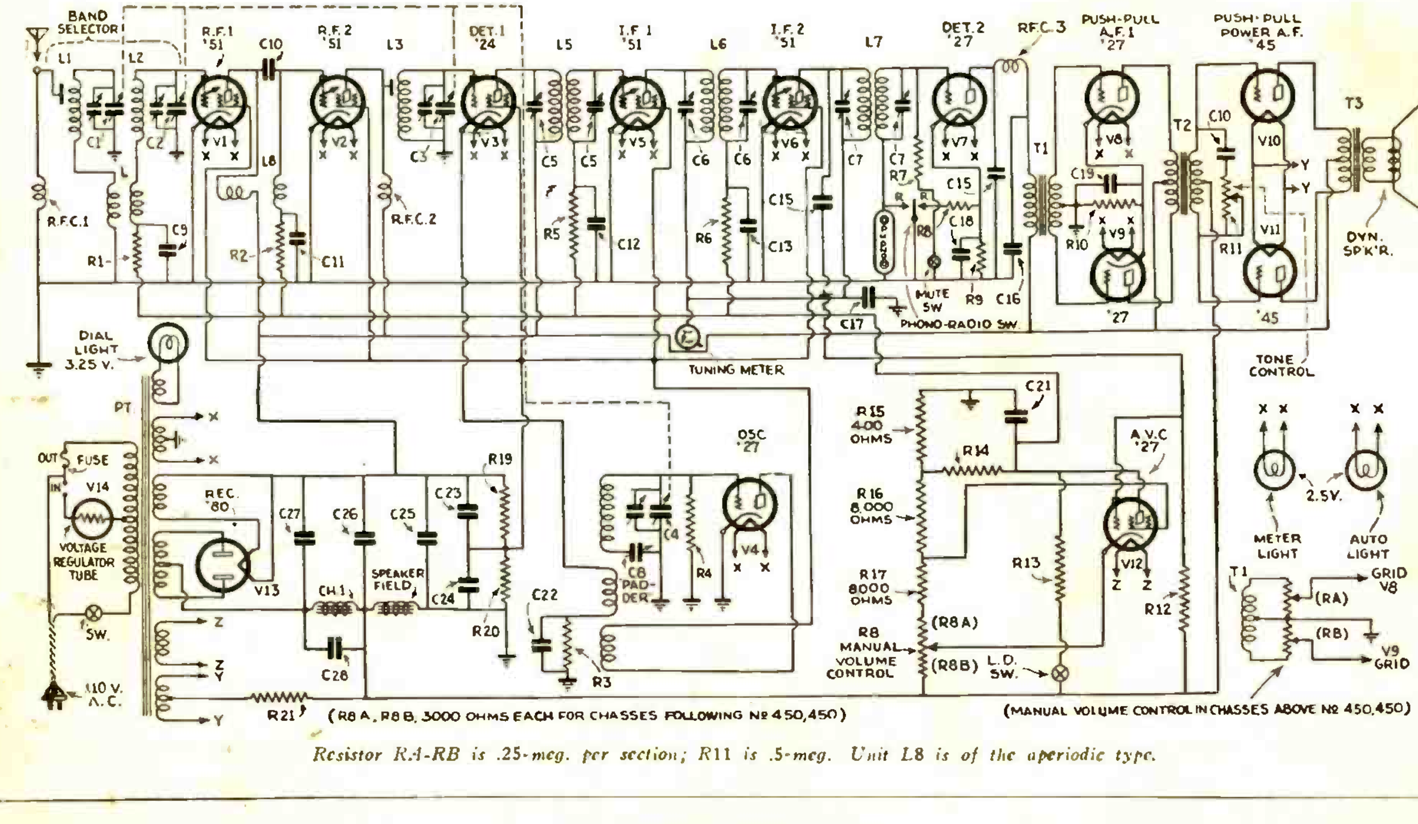
The six I.F. adjusting screws provided beneath the chassis, directly under the I.F. transformers, are to be used *only when it is absolutely certain* that the trouble lies at that point and should be carefully checked.

If it is necessary to change the setting, connect an accurate 175-kc. test-oscillator to the ground post, and to the first-detector grid-cap through a fixed condenser of .00025-mf. capacity (the oscillator tube must be removed for this operation). Beginning with the first-detector plate-screw (the one farthest to the left when viewing the chassis from underneath with the control shafts at the top), each one is tuned for maximum swing of the V.I. meter; this operation applies to all but the second-detector grid-circuit trimmer. Since the meter is not affected by this circuit, it will be necessary to adjust it to a point which results in greatest volume.

The line fuse may take two positions. Normally, it should be in position "regulator tube in"; if the regulator tube V14 becomes defective and a replacement is not immediately available, the fuse may be transferred to the "regulator tube out" position. The regulator tube is a protection to the entire receiver, and a defective regulator should be replaced at once.

The phonograph jacks and "phono-radio" switch are in the grid-return circuit of second-detectors V7-V8; this will result in a "howl" sound when the switch is changed to the "phono." position, if the circuit is not completed through a pickup. Keep this in mind if the complaint is, "weak reception accompanied by a howling sound."

Previous Data Sheets have discussed the selection of a suitable tube for use in A.V.C. circuits.



Resistor RA-RB is .25-meg. per section; R11 is .5-meg. Unit L8 is of the aperiodic type.

CROSLEY "LITLFELLA," MODEL 125 SUPERHETERODYNE

(Midget 5-Tube Receiver)

The sensitivity of the Model 125, or "Litlfella," Midget Superheterodyne, which is illustrated by the diagram below, is about the same as that of a moderate-sized tuned-R.F. receiver, and may be used with an equivalent average antenna.

The first tube, V1, is connected in an autodyne circuit, that is, it acts both as a detector and as an oscillator. Two of the condensers in the gang unit are in the circuits of the signal-frequency band-selector, the remaining condenser tunes the oscillator circuit.

The electrical values of the parts used in this superheterodyne are as follows:

Resistor R1, volume-control resistor; R2, bias-limiting resistor; R3, 20,000 ohms; R4, R5, 6,500 ohms; R6, 15,000 ohms; R7, R10, R13, 1. meg.; R8, R12, 40,000 ohms; R9, 300,000 ohms; R11, 25,000 ohms; R14, 350 ohms; R15, 20 ohms, center-tapped.

Condensers C1, C2, C3, tuning gang; C4, .001-mf.; C5, I.F. trimmers; C6, C7, C8, C12, 0.1-mf.; C9, C14, 0.5-mf.; C10, .0005-mf.; C11, .00025-mf.; C13, .02-mf.; C15, .05-mf.; C16, 6 mf.; C17, 8 mf.

The five tubes are: Oscillator-first-detector, V1, type '24; first I.F. amplifier, V2, type '35 or '51; second-detector, V3, type '24; A.F. amplifier, V4, type '47 pentode; rectifier, V5, type '80.

It is *extremely important* that good tubes be selected for use in the oscillator-~~second~~-detector stage, V1.

The intermediate frequency used in the Model 125 chassis is 175 kc. The I.F. trimmer condensers C5 are adjustable through holes at the left side of the chassis, near the front, as viewed from the front of the receiver.

The R.F. and oscillator condenser-trimmers are adjusted from the top of the chassis, through three holes in the condenser shield.

Average operating characteristics of the tubes are as follows: Filament potential, V1, V2, V3, V4, 2.4 volts; V5, 4.8 volts. Plate potential, V1, V2, 85 volts; V3, 87 volts (250-V. scale), 25 volts (50-V. scale); V4, 215 volts. Control-grid potential, V1, 6.5 volts; V2, 2 volts (25 vol.-cont. off); V3, 5 volts; V4, 1. volt. Screen-grid potential, V1, V3, 85 volts; V2, 20 volts (250-V. scale), 5.5 volts (50-V. scale); V4, 215 volts.

This data shows the average voltages when measurements are made with a voltmeter of 1,000-ohms-per-volt type; under these conditions the actual pentode control-grid potential of 16 volts may be indicated on the meter as only 1. volt.

Note the unusual circuit connection of the special 3-contact reproducer-plug.

The first-I.F. transformer may require adjustment; the second one is of the "aperiodic" type and therefore does not require adjustment. The rotor plates of the oscillator tuning-condenser are so shaped as to eliminate the need for a "padding" condenser to maintain alignment across the tuning band. It is advisable to use a service oscillator for the aligning process, rather than the signal of a broadcast station.

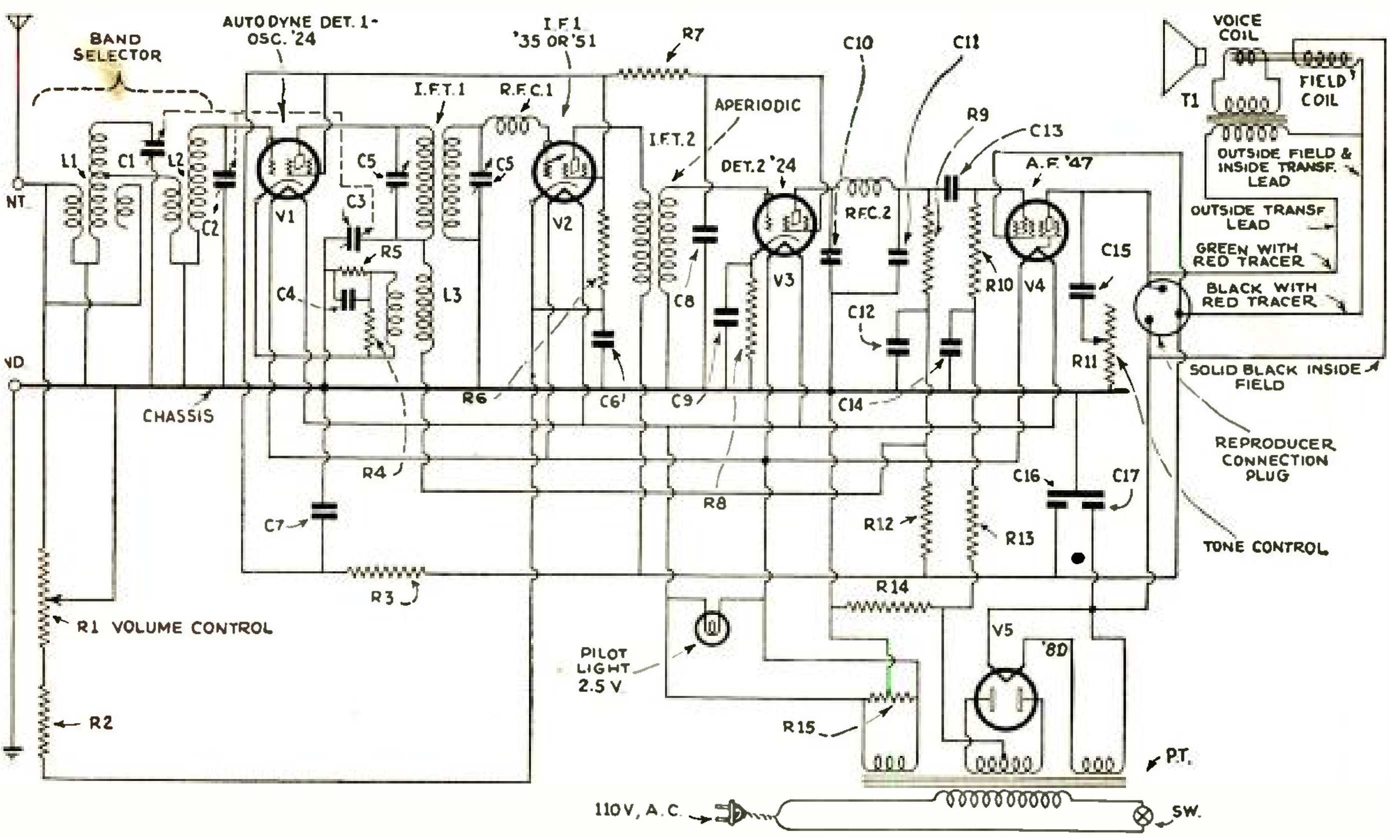
Tune to a signal between 1,300 and 1,400 kc., and turn the volume control all the way on. If all signals within the required range are too loud, connect a fixed condenser of .00025-mf. between the "A" and "G" terminals, and then couple the antenna very loosely to a wire connected to the "A" terminal.

If, when carefully tuned to the middle of the band, the dial reading does not correspond to the signal frequency, but is not more than two channels off, set the dial at the correct frequency, and adjust the oscillator trimming condenser. Check the tuning by readjusting the station selector. It may not be possible to regulate the oscillator trimming condenser so that the oscillator condenser is properly aligned with the *exact* dial setting, in which case align the trimmer with a dial setting as close to the actual frequency as practicable.

After aligning the oscillator trimming-condenser, retune to a frequency between 1,300 and 1,400 kc. and carefully adjust the trimming condensers on the other tuning condensers until the signal is received with greatest volume.

If a screwdriver of insulating material is not available, adjustment may be made with an ordinary screwdriver by turning the screw slightly, removing the screwdriver, and retuning—repeating this process (being sure to turn the screw in such a direction that the tuning approaches more nearly the desired frequency, of course) until the dial setting agrees with, or approximates, the actual signal frequency. The latter procedure is rather hit-or-miss, and should be resorted to, only where the regulation insulated tool is unavailable.

To align the I.F. circuits, leave unconnected the antenna and ground leads, and remove the receiver lead from the control-grid cap of the oscillator-detector V1. Then, connect one of the service oscillator-leads to the control-grid cap of this tube, and the other to the grounded chassis, and operate the oscillator at the I.F. of 175 kc., adjusting the I.F. trimmers C5 for maximum response from the reproducer or aligning meter. Always realign the signal-frequency tuning-condensers after the I.F. circuits have been resonated.



Volume-control resistor R1-R2 (Part No. W-23,618-A) has a total value of 4,500 ohms; fixed section R2 is 160 ohms.

The RADIO CRAFTSMAN'S Page

The Bulletin Board for Our Experimental Readers

HE FOLLOWED OUR ADVICE

Editor, RADIO-CRAFT:

Some time ago I wrote you asking for some advice as to the best course to take to get work, etc., and want to thank you for your answer. I am writing to advise you how it turned out, as you requested.

I took your advice, given in a copy of RADIO-CRAFT, to specialize in a certain line of work and I took up winding radio power transformers; then I put an advertisement in RADIO-CRAFT which was fruitful in results and, strangest of all, landed me in a position in the city in this class of work, very much to my surprise. RADIO-CRAFT surely did its work double—brought me several customers and a good position thrown in. How's that for a small want-advertisement in your paper?

Thanks very much for past help and assure you RADIO-CRAFT and I are better friends than ever.

LEE C. MAPES,
16 *Fulton Ave., Rochester, N. Y.*

MR. FITCH REPLIES

Editor, RADIO-CRAFT:

Dr. Robinson's letter answers the questions raised by me in the November, 1931 issue of RADIO-CRAFT in a very clear manner, and explains some interesting technical features of the "Stenode" system which I believe were not generally known. His statements may be briefly summed up as follows:

First: The selectivity of the "Stenode" is determined by the frequency characteristics of the audio amplifier. This can be designed to cut off at 5 kc. and produce a flat-topped response curve ideal for broadcast reception.

Second: A modulated carrier differing in frequency by 5½ to 6 kc. from the desired one will produce no interference because of the phenomenon of *detector demodulation.*

Third: Frequency modulation offers possibilities and new results will probably be forthcoming when the subject is fully investigated.

From the above, it would appear that the "Stenode" is an ideal receiver, and to hear one in operation one would certainly think so. But there are, no doubt, some practical problems to solve, once the theory has been correctly established, before the system comes into general use. In the first place, the highly selective quartz-crystal circuit produces effects inversely proportional to the modulation frequency of the carrier; therefore, the receiver must be tuned *exactly* to the frequency of the incoming carrier. If tuned, say, a few hundred cycles away from the carrier, the effects will not be inversely proportional to the modulation frequency of the carrier, and distortion will result.

A method of tuning the receiver exactly to the carrier has been perfected by means of tuning dials having a very high reduction ratio. But has any practical method been produced for holding the receiver exactly in tune? While the quartz crystal may be permanent enough for practical purposes, it would seem that the frequency of the local oscillator for heterodyning might vary sufficiently to throw the receiver out of tune; and the set would constantly have to be retuned. This may be objectionable to a radio public used to rough tuning on the average broadcast receiver. This disadvantage is offset at the present time only by a decrease in interference. A greater advantage of the universal use of the "Stenode" system would seem to be in providing space in the ether for nearly twice as many stations as are now possible.

CLYDE J. FITCH.

PAGE MR. GUNSOLLEY

Editor, RADIO-CRAFT:

Mr. Gunsolley's letter of October 21st, 1931, shows that he is not well informed of the theory and practice of "Stenode." He says that as he has not had a demonstration of the "Stenode," it would be useful to have an independent report from the Bell Laboratories. We have had so much advice to submit our instruments to independent laboratories that it would have been physically impossible to get in touch, for this purpose, with all the firms suggested. We have submitted our instruments for tests on numerous occasions, but we have usually done so on direct invitation from the firms concerned.

Probably Mr. Gunsolley has seen the published results of Crosley's tests of the "Stenode."

There is one very significant statement in Mr. Gunsolley's letter as follows: "If it can stand on the sales floor and outrival other receivers in both selectivity and tone quality, such an authorized report would cause the maddest scramble for manufacturing rights the radio industry has ever experienced." It may interest him to know that the "Stenode" has stood on a sales floor in England, and has been compared with the best receivers in England, and does outrival all other receivers in both selectivity and tone quality.

Mr. Gunsolley still appears to think that frequency modulation may account for some or all of the results of the "Stenode." Again, he appears to think that some one has claimed that frequency-modulated waves have no side bands. I sent a letter to you dated November 13th, 1931 in which this whole problem is discussed.

Further than this, the theoretical reasons for the operation of the "Stenode" are given, showing why quality and selectivity are obtained, and further, why interference is reduced to a much lower level than is possible by any other receiver. The publication of that letter should enlighten Mr. Gunsolley, and many other readers of yours, as to the new scientific facts brought out by the "Stenode."

If Mr. Gunsolley still has points on which he is not clear, I shall be glad if you will forward me his comments.

JAMES ROBINSON.

(The letter of Mr. Gunsolley to which Mr. Robinson refers, was not published; its salient inquiries, however, are quoted, above. The letter of November 13th, to which he refers appeared in the February, 1932 issue of RADIO-CRAFT; it is reviewed by Mr. Fitch.)

"THE RADIO EXPERIMENTER"

Editor, RADIO-CRAFT:

In a recent editorial you had a kind word to say for the independent experimenter, pointing out that sometimes he is a step or two ahead of the manufacturer. May I call your attention to an experience of my own that illustrates your last statement.

Several years ago I invented a combined electric phonograph and home recorder, using a microphone for recording and a change-over switch to put the machine into either operative condition. When I brought this to the attention of phonograph manufacturers, I explained to them that here was a new and promising field, an acoustic companion to the home camera, but they could not see it that way and turned me down.

Now, since then, what has happened? Electric phonographs with home recording attachments are in the market, and indications are that this new field is rapidly expanding. Those manufacturers who could see nothing useful in my invention will now find that their home recorders infringe on my patent No. 1,827,051, issued October 13, 1931, a copy of which I enclose for your information. Please look at claims 21 to 25, which are fundamental and in my opinion control the entire art of electric phonographs provided with home recording mechanism.

ADOLPH A. THOMAS,
36 *West 44th St., New York.*

(The editorial to which Mr. Thomas refers was published in the October, 1931 issue of RADIO-CRAFT, and written by Mr. H. Gernsback.)

Synchronizing Sound

(PART II)

By HERBERT C. McKAY

IN the February issue of RADIO-CRAFT there was described in detail the construction of stroboscopes for home projectors and recorders. Their use will now be discussed.

The Multi-Stroboscope

If you want to make an experiment to show what the stroboscope will do, make a disc for the phonograph which has a triple scale, the outside containing 91 segments, the central one with 90 and the inside one with 89 segments. These divisions correspond respectively to record speeds of 79.12, 80 and 80.89 revolutions per minute. When the central division is standing still the outer one will move forward and the inner one backward although the difference is less than one revolution per minute.

A quadruple scale is shown in Fig. 2, with the outer one containing 100 segments, the next 96, then 94, and the inner one 90. These correspond to R.P.M.'s of 72, 75, 76.6, and 80, respectively.

It will not be difficult to get the two machines running together. When this is done, place an index mark upon both machines to indicate this point. In later work this will serve as a starting point and in the case of the turntable, at least, little variation will be found to be necessary. However, the turntable may speed up due to the lessened pull as the recorder head approaches the center of the record. If this is the case determine the range of the speed control lever to hold it at the right speed at beginning and end of the record. Set the speed control midway between the two so that while the record may run slightly slow at the beginning, it will make this up later. The error will not be noticed on the second and third types of recording. For lip-synchronization, it will be necessary to have both machines under control and keep them together. In this case a second operator must control the speeds while the speaker devotes his entire time to the matching recording.

As for the actual recording, it is simple. Assuming that the speeds are under control, and that the recording factors such as microphone current, volume control, and so forth, have been set, you are ready to match.

Project the film two or three times, maintaining speed to familiarize yourself with the general sequence of scenes. Determine the effects you desire or the words you want to use. Stop the projector at the end of each scene to make a note of it upon a sheet of paper.

Now with this scenario before you, project the film *at proper speed* and rehearse the sound. Do this at least three times. When this has been done and no changes contemplated, set the record, insert the film in the projector with the frame in the gate marked with a cross or other indicating mark and proceed to make the record as indicated in Fig. E.

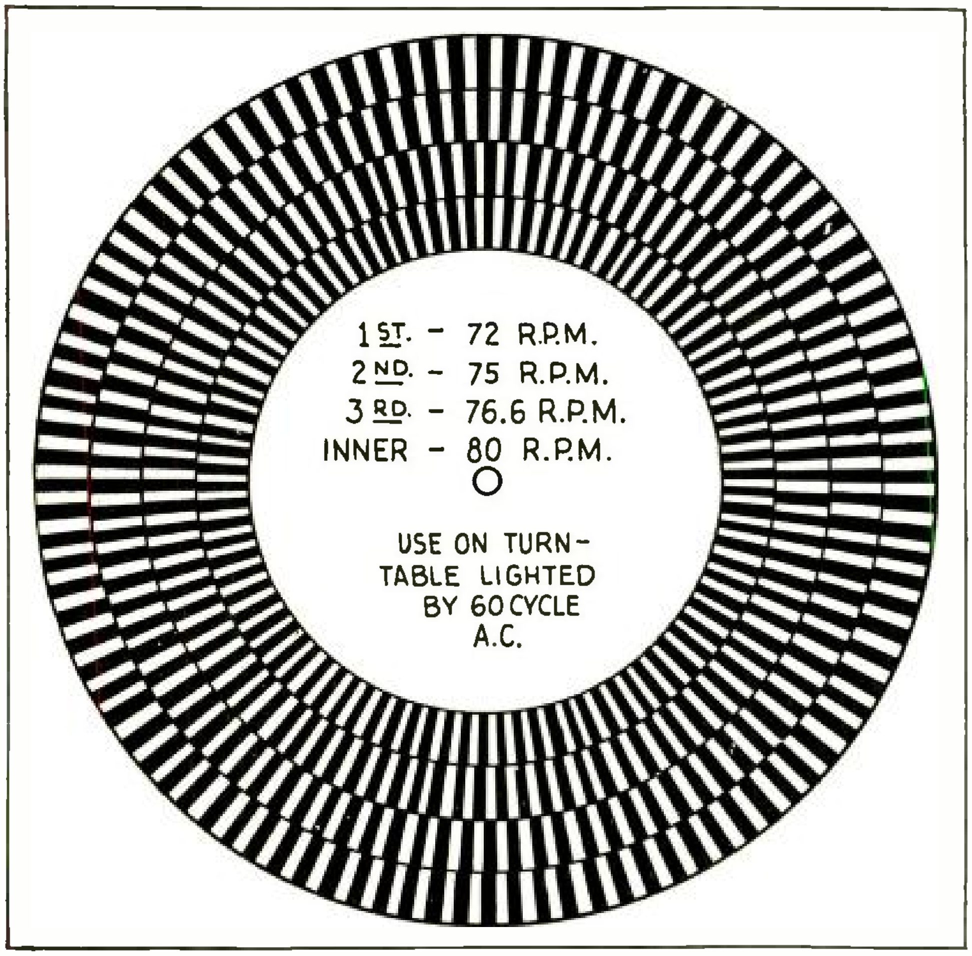


Fig. 2

A quadruple stroboscope suitable for home recording. If the speed of the turntable is, for instance, 76.6 R.P.M., then the two outer scales will seem to rotate in one direction and the inner scale in the other.

Synchronizing Sound and Film

When the record is complete, remove it from the recorder table and examine the first groove with a hand lens. Find the start of the groove. This is to be marked with the start mark. A phonograph needle set in a strong chuck-type pin vise is a good instrument for this purpose. Set the needle point in the groove, right where it starts. Be careful not to let it push over into the second groove. Then with steady pressure draw it out in a short arc to the edge of the record. This start arc should be about one inch long. Then to play, all that is necessary is to place the needle somewhere in this arc and start the table. The error of an inch or so will not be noticeable.

When this is done you are ready for the test run. Place the record upon the turntable, and with the pickup in place determine the position of the speed control for playing which will maintain the original recording speed.

With this determined, place the film in the projector with the starting frame in the gate, place the needle in the starting groove and start both machines. Incidentally it may be remarked that a single control switch with a "Y" connection for the two machines will greatly facilitate starting and stopping together.

If the recording has been carefully done, the playback will be surprisingly good.

The addition of sound to your old films, which you have not used for a long time will give them new interest and you will find that they possess an interest which you would hardly believe. Once you get the "knack" of matching, you will make records for all of your films and find yourself in possession of a truly enviable library of talking films.

R. F. Coil Design

(PART II)

Factors governing the design of the primary of R. F. transformers are discussed in detail by the author in this, the second of a series of articles.

By C. W. PALMER

IN the December, 1931 issue of RADIO-CRAFT, some facts concerning the correct design of tuning coils were presented. In that article, we considered the *secondary* coil of the usual inductively-coupled T.R.F. transformer. At that time we promised another article covering the *primary* inductance for aerial and inter-stage coupling.

In the following discussion are given some hints on the design of coils for the screen-grid, variable-mu and, especially, for the new R.F. pentode which is destined to find its way into most of the new commercial sets.

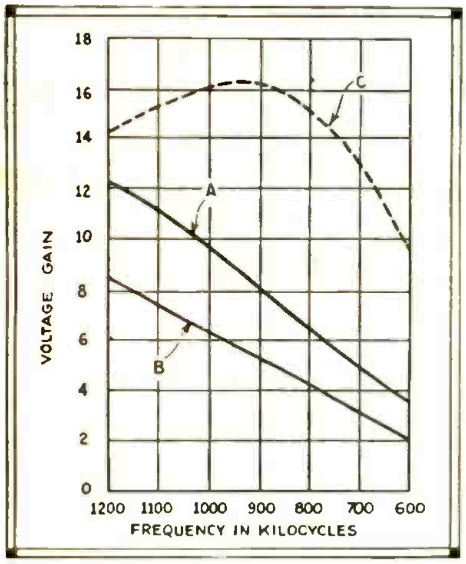


Fig. 1

The dotted curve illustrates the response of a typical close-coupled primary. At A and B, the same transformer with reduced coupling.

Aerial Coupling

First, we will consider the coil coupling the aerial to the first tube. The main problems in the design of this type of coil are:

1. Elimination of cross-talk.
2. Reduction of aerial capacity reaction causing the aerial circuit to tune differently than other circuits.
3. Development of a system with fair selectivity and with a satisfactorily even step-up over the band of frequencies.

The phenomenon of "cross-talk" has become more evident with the increase in R.F. gain resulting from improvements in vacuum tubes. It is a form of interference in which a station may be tuned in on one or more carriers (stations) other than its own channel. It is different from the usual interference (due to broad tuning) as it is generally noticed only in the proximity of powerful local stations which deliver a large input to the receiver. If this interfering carrier reaches the grid of the first tube, it is amplified in the usual manner, but, at the same time, partial rectification occurs and this rectified signal in the plate circuit modulates the carrier to which the set is tuned, thus producing the cross-talk.

The variable-mu tube with its automatically adjusted mutual-conductance characteristic reduces this interference to a very small factor, but it is not always desired to use these tubes in a set (for example, in certain commercial receivers).

There are two general methods of overcoming the difficulties outlined above. As transformer methods of aerial coupling are the most satisfactory for general use in reducing cross-talk, both methods explained below employ inductive coupling.

The capacity reaction of the aerial is also best overcome by a correctly designed aerial-coupling transformer; and the third point of even voltage step-up is a problem of correct primary-coil design in the aerial coupler.

Spaced Primary

The method generally employed is to use a primary of very low impedance (5 to 20 turns) coupled very closely to the secondary. Fig. 1 shows the voltage gain of a typical coil of this variety with a coupling coefficient of about 40%. This tight coupling, however, is very unsatisfactory on the high-frequency end of the band. In the first place, the antenna loading effect reflected on the secondary is so great that difficulty is encountered in tuning down to 1500 kilocycles. In the second place, the loading due to the aerial and the dielectric losses between primary and secondary are so great that the first stage tunes very broadly, making it necessary to reduce the coupling by tapping the primary or by using an antenna series-condenser.

The transformer used in Fig. 1 consists of 80 turns of No. 30 wire space-wound on a $2\frac{1}{2}$-in. tube with a primary of 20 turns wound directly over the secondary with a layer of insulating paper between. The gain falls rapidly below 850 kc. due to a reduction in the voltage transfer. Above 1000 kc., the gain also drops due to antenna loading and dielectric loss. The gain of this transformer is very uneven and, in addition, the selectivity is exceedingly poor (90 kilocycles at 1200 kc.).

A reduction of the coupling coefficient to about 10% overcomes the above disadvantages as shown in the curve A of Fig. 1. Although the gain drops considerably, the selectivity is increased to 42 kc. at 1200 kc. which is quite satisfactory. In a receiver developing sufficient R.F. amplification, the coupling may be further reduced (Fig. 1B).

The coil used for obtaining curves A and B consists of a secondary of the same size as the dotted one, but the primary is spaced $\frac{1}{8}$-in. away from the secondary coil and is wound on the smallest convenient amount of insulation. The primary in curve A contains 10 turns of No. 30 wire closely wound; that in curve B contains 6 turns.

High-Impedance Primary

The second method of aerial coupling which answers the requirements is one which has been developed recently and is being used with much success in some of the newer receivers. As in the first case, it is a transformer method of coupling; but, unlike the first, it contains a primary of considerable impedance. This primary is adjusted to a frequency just below the lowest to be received; i.e., below 550 kc. Very loose coupling of the order of 10% is employed. The aerial reaction reduces the effective secondary inductance but, owing to the very loose coupling, it is of very small magnitude. The gain in this arrangement decreases as the frequency increases but, as we will find later (due to the falling characteristic with an increase of frequency in interstage couplers), this is a very desirable condition.

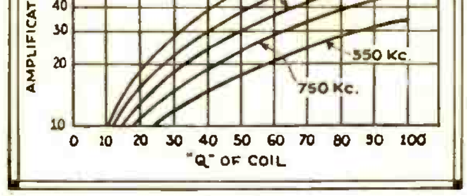


Fig. 3

Response of an R.F. circuit at different frequencies and for coils of various "Q's."

An aerial coupler of this type consists of a coil of about 380 turns of No. 36 S.C.C. wire, wound jumble fashion in a spool-shaped form as shown in Fig. 2. The form is ½-in. in diameter and the complete spool is mounted at the grounded end of the secondary. The latter coil is made as explained in the article in the December, 1931 issue of RADIO-CRAFT.

Interstage Coupling

The problems encountered in coupling one tube to another are quite different than for aerial coupling. Some of the main requirements are as follows:

1. A coil which will produce a high degree of coupling without loading the secondary circuit excessively.
2. A circuit arrangement which will result in a high primary impedance, so that the high amplification of the screen-grid and pentode tubes can be realized.
3. Development of a system which will produce satisfactorily even amplification over the frequency band.

While the screen-grid, variable-mu and R.F. pentode tubes are capable of yielding a very high amplification of a signal voltage, it is not practical to utilize the full gain for several reasons. In the first place, the shielding effect of the screening grids is not completely effective. A small capacity still exists between the control-grid and the plate which allows a feed-back of current from plate to grid when the signal voltage is increased to a high factor.

In addition, it is extremely difficult to produce effective shielding in a radio frequency amplifier with such capabilities, and the combination of tube feed-back with this external coupling permits the tubes to oscillate above a certain amplification level. As this effect is cumulative, increasing rapidly as the number of tubes and tuned circuits is increased, the maximum amplification per stage must be reduced about 20% for each R.F. tube over two. In commercial practice, it is not practical to utilize more than one-half the maximum rated tube amplification.

The actual gain in an R.F. amplifier depends on the resistance of the tuned circuit (known as the "Q" of the coil), the degree of coupling between the primary and secondary, and the mutual conductance of the tube. The value of the coil's dissipation value "Q" mentioned above is equal to

$$\frac{6.28 \times f \times L}{R2}$$

where f is the frequency in kilocycles, L the inductance in millihenries, and R2 the

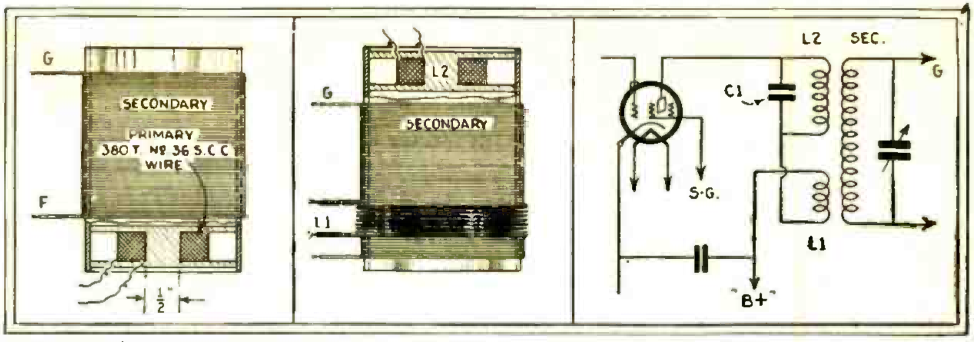


Fig. 2, left. *Location of the primary in a high-impedance type R. F. transformer.*
Fig. 5, center. *Arrangement of the primaries in a "flat top response" transformer.*
Fig. 4, right. *Diagram of connections of the multiple primary transformer.*

R.F. resistance of the secondary tuned circuit. As we can readily see from this formula, the lower the resistance of the secondary, the higher will be the efficiency of the tuned circuit. However, this is dependent more on the design of the secondary coil than the primary and, for illustration purposes, we will assume that we have a coil with a "Q" of about 90 to 100. Then from Fig. 3, we can see that if the coupling between the primary and secondary is kept

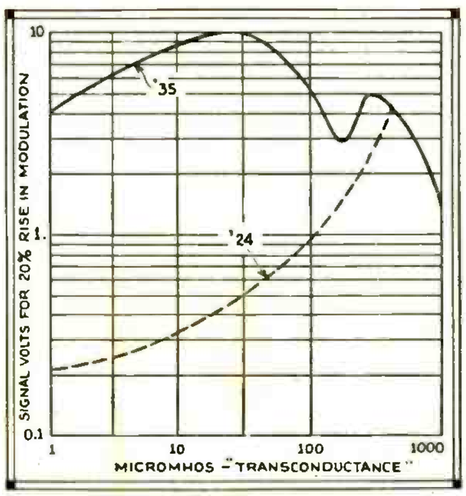


Fig. 6

Maximum allowable input voltage of a '35 compared to a '24, for 20 per-cent modulation rise.

constant, the amplification will not be equal for various frequencies, but will increase as we tune to a higher frequency.

This effect which is pictured for a single stage increases as the number of stages is increased. Thus we can see that we are limited in the amplification that we can obtain (by the oscillation), and in the number of tubes we can use (by the frequency factor).

A number of methods have been suggested and used to overcome the latter difficulty. One is to use a "cam" arrangement on the tuning condensers, introducing a small capacity into the circuit to increase the coupling. Another is to employ capacity coupling between the tubes. Still another is to move the primary coil in conjunction with the tuning condensers to vary the coupling and reduce the amount of amplification at the higher frequencies.

One method which appeals to the writer as being the most logical presented to date is to use a primary circuit which is balanced, so that part of the primary having a large self-inductance is not effective at the higher frequencies; in this manner, the coupling is automatically adjusted to even the amplification.

The above system is explained as follows; two primary coils are used, one coupled to the grounded end of the secondary coil in the usual manner as shown in Fig. 4. Another coil, shunted by a condenser, is coupled to the grid end of the secondary coil and the two primaries are connected so that they are opposing or bucking each other. Now suppose we tune to a long wavelength or low frequency—the first primary coil L1 has very little effect because it is made purposely small. On the other hand, the second primary coil L2 is closely coupled to the secondary and the signal is transferred through this medium. This primary is quite large and comparatively closely coupled to the secondary, so that a large coupling exists.

As the frequency is increased, more and more difference exists between the resonant frequency of the primary and that of the secondary, resulting in L2 having less and less effect. However, the first primary becomes more effective as the frequency increases and, as this coil is comparatively small, the amplification is not as great as it was at the low-frequency end of the band. At the high-frequency end of the band, the primary coil L2 would ordinarily act as a choke coil and prevent L1 from functioning, so a condenser C1 is shunted across L2 to act as a bypass for the signal voltage; the circuit L2-C1 is tuned to a frequency just below the lowest frequency to be received.

The constants of a coupling coil of the type described above are as follows (as the system is rather complicated, the values given apply only to the example and correct requirements must be found by varying the coupling of the two primaries until the desired results are achieved): the secondary is the same as that described for the aerial coupler of Fig. 1; the first primary L1 is wound over the grounded end of the secondary with suitable insulation between and contains 25 to 50 turns of No. 34 or 36 wire, depending on the number of tubes to be used; the second primary L2 is wound in a spool-like form ½-in. in diameter and ¼-in. wide and is inserted in the grid end of the secondary coil, it being jumble wound and contains 450 turns of No. 36 D.S.C. wire; the condenser C1 is a small condenser of 35 mmf.

(*Continued on page* 569)

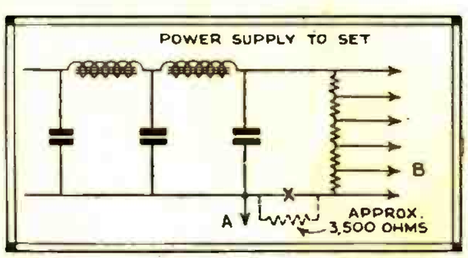


Fig. 7

Changes in the power supply necessary to control volume with variable-mu tubes.

RADIO-CRAFT KINKS

Practical hints from experimenters' private laboratories.

Prize Award, $5.00

A 6-VOLT BATTERY FOR 2-VOLT TUBES

By Audie Roberson

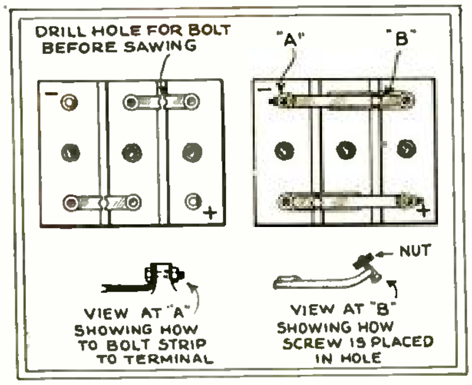


Fig. 1

A conversion that certainly makes for economy. Old 6-volt storage batteries may be rebuilt as described by the author for use with new 2-volt battery tubes.

NO doubt the best way to furnish power for the 2-volt tubes is by using the Air-Cell battery, but a great many people have an old 6-volt storage battery and are reluctant to throw it away. They may easily be converted to 2-volt batteries and I believe that it is economical to do so.

The first operation is to saw the connecting bars as shown in Fig. 1. The center cell is then raised and its position reversed; when placed back, it will appear as shown. Now procure two strips of lead connectors that will just reach across the battery and bend one end so that it will fit as shown. A hole is then drilled through the connector and the battery post so they may be securely fastened.

Now as near as possible to the ends of each cut connector bars, drill a hole. The bars are then bent upward until a bolt can be inserted and then bent down with the end of the connector bar fastened to the battery post as shown in the sketch. Two more holes are drilled to correspond with the holes in the cut connectors which are then bolted securely as shown. It is well to sandpaper each connection before tightening so that the very best connections can be obtained.

$5 FOR A PRACTICAL RADIO KINK

As an incentive toward obtaining radio hints and experimental short-cuts, RADIO-CRAFT will pay $5.00 for the best one submitted each month. Checks will be mailed upon publication of the article.

The judges are the editors of RADIO-CRAFT and their decisions are final. No unused manuscripts are returned.

Follow these simple rules: Write, or preferably type, on one side of the sheet, giving a clear description of the best radio "kink" you know of. Simple sketches in free-hand are satisfactory, as long as they explain the idea. You can send in as many kinks as you wish. Everyone is eligible for the prize except employees of RADIO-CRAFT and their families.

This contest closes on the 15th of every month, by which time all the Kinks must be received for the next month.

Send all contributions to Editor, Kinks Department, c-o RADIO-CRAFT, 98 Park Place, New York City.

PLUGS AND JACKS IN THE LAB.

By Joseph Riley

SINCE the convenience and adaptability of plugs and jacks in the laboratory are not known to every experimenter, the writer ventures to call attention to the numerous arrangements illustrated in Fig. A. Although not new, having appeared originally in an issue of the "General Radio Experimenter," it is believed they are excellent examples of the versatility of plugs and jacks.

The following lines are quoted from this interesting number of the "Experimenter":

"In the laboratory, the space provided under the bench too often becomes the resting place for discarded "breadboards," a procedure which soon proves both unsightly and uneconomical. A satisfactory solution is a "universal breadboard" provided with the necessary jacks for plugging in various circuit elements. This sort of device is illustrated in Fig. B.

"To meet this need for a flexible system of connection, "G. R." units have been designed around the Type 274 plugs and jacks. A spacing of ¾-in. has been adopted."

This manner of arranging test equipment makes it extremely convenient to make comparisons between units of a given type, such as audio transformers; for that matter, even systems of operation may be compared, such as the relative performance of transformer or resistance audio-amplification, provided the voltages, etc., are correctly balanced.

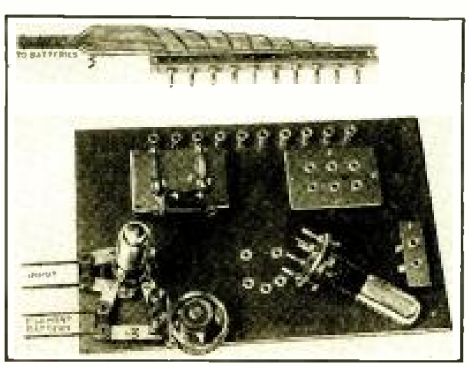


Fig. B

A laboratory breadboard illustrating one of the many uses for which plug and jacks may be used. Observe the clean-cut arrangement of the parts.

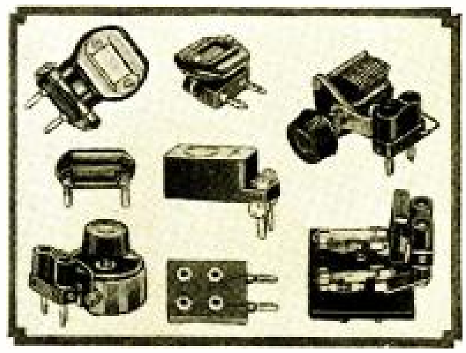


Fig. A

A number of plug and jack arrangements that facilitate experimental work. It is clean-cut apparatus like that illustrated above which makes experimenting easy.

POPULAR RADIO ACCESSORIES

By J. G. Sperling

IN spite of many opportunities, the average Service Man does not avail himself of the possibilities of selling various radio accessories in the home.

The writer has carried a few items in his kit for the past year, all of which have proven very successful. It is a rare home, indeed, in which at least one of these accessories could not be sold.

Noise Reducer

The first of these accessories is a noise or static reducer. As seen from Fig. 2, it consists of a neon glow-lamp in series with a variable resistance. This device is connected across the voice-coil terminals of the loud-speaker. Its operation is relatively simple, it being a form of an automatic volume-control. First, the manual volume-control is set at some definite level. It will be necessary to mark this point on the dial, for successful operation of this device depends upon the correct position of this volume control. Then the variable resistance in the unit is adjusted till the lamp starts to flicker.

Therefore, if there are any extraneous noises such as static or electrical interference it will be shunted or bypassed through this device. There will not be any loud crackling such as previously present, but only a low-pitch noise or "plop" whenever there is a large amount of static. Whenever this occurs, the neon lamp will glow.

The parts used in this device are a G.E. 1-watt neon glow-lamp with a small Edison base, and a 10,000-ohm variable resistor.

(Continued on page 568)

Radio-Craft's Information Bureau

***SPECIAL NOTICE TO CORRESPONDENTS:** Ask as many questions as you like, but please observe these rules:*

Furnish sufficient information, and draw a careful diagram when needed, to explain your meaning; use only one side of the paper. *List each question.*

Those questions which are found to represent the greatest general interest will be published here, to the extent that space permits. At least five weeks must elapse between the receipt of a question and the appearance of its answer here.

Replies, magazines, etc., cannot be sent C. O. D.

Inquiries can be answered by mail only when accompanied by 25 cents (stamps) for each separate question. *Other inquiries should be marked "For Publication," to avoid misunderstanding.*

LINCOLN MODEL D.C. SW 10 ALL-WAVE RECEIVER

(149) Mr. Robert Smilovitz, Carnegie, Pa.

(Q.1) In the January, 1932 issue of RADIO-CRAFT, on pg. 417, was shown the schematic circuit of the Lincoln DeLuxe SW 32 All-Wave Receiver. In the article describing this circuit, mention was made of a battery model. Please show the schematic circuit of this receiver.

(A.1) In Fig. Q.149 is illustrated the schematic circuit referred to, the Lincoln Model D.C. SW 10 All-Wave Receiver.

All available parts values appear in the diagram.

In general, the circuit is the same as used in the A.C. model, except for the changes necessary for the utilization of battery power for the "A," "B," and "C" circuits.

INSTALLING AUTO-RADIO REMOTE CONTROLS

(150) Mr. James Peterson, Bronx, N. Y.

(Q.1) Please describe in detail the manner in which Carter auto-radio remote control units are mounted in the car and adjusted to the radio set. As indicated in the illustration (reproduced here as Fig. Q.150A), there are 10 main parts to the assembly; and just how they can be adapted to various installations is not at all clear.

(A.1) The parts referred to in the illustration bear the following classifications: (A), control head with control cable and electric cable attached; (B), two semi-circular clamps for securing the head to the steering post (one grounding set-screw in each); (C), four 8-32 x 1⅛-ins. round-head screws (to attach clamp to control head); (D), four No. 8 internal tooth lock-washers (for clamp screws); (E), two leather spacers; (F), one brass hexagon cable-chuck (consisting of three parts); (G), one condenser pulley (with two set-screws in hub and cable clamping screw and washer); (H), one spiral spring; (I), one centering ring; (J), two keys for lock.

In mentioning the condenser pulley G, the centering ring encircles the condenser shaft with the lugs projecting through the condenser end plate. These holes should be ⅛-in. in diameter and ⅞-in. between centers. They are provided on some condensers, but will have to be drilled in some others. When the ring is in place, bend the lugs over on the inside of the end plate.

The inside turn of the spiral spring is provided with an offset bend. This is locked in the slot in the centering ring and the loop on the outside turn is placed on one of the twelve projecting pins on the condenser pulley. The spring is then wound by turning the condenser pulley on the shaft. Usually about one turn provides sufficient tension. The pulley set-screws are then tightened on the shaft, being careful that some clearance is allowed between the projecting pins and the condenser end plate to prevent binding. When the proper tension has been determined, it may be that the cable clamping screw on the pulley is not in the proper position for operation. The same tension can be maintained and the position of the clamping screw corrected by moving the loop on the outside turn of the spiral spring to a different pin on the pulley. A minimum of ⅝-in. clear space and 9/16-in. condenser shaft extension is required at one end of the condenser for mounting the condenser pulley.

The cable chuck, which is in three parts, can be mounted in the receiver housing or on a bracket secured to the condenser or chassis. It mounts in a ⅜-in. hole, the large jam nut fitting on the tapered end and the lock nut on the short end. This chuck may be located any distance from the condenser pulley but should be in line with the center of the groove in the pulley.

Now, turn the selector knob as far as it will go in a clockwise direction, to begin the procedure of mounting the control unit. This draws the cable into the tubular housing and protects it from injury at the free end. Keep it in this position during installation. The control head A is mounted on the steering post with the knobs projecting toward the right-hand side. The proper distance below the steering wheel can be determined by trial. If the steering post is 1½ ins. in diameter, use the leather spacers E. If 1⅝ ins., split the spacers or wrap the post with about 1/16-in. of friction tape, under the brackets. If the post is 1¾ ins., spacers are not required. Use the lock washers D under the heads of the clamp screws C for securing the clamps B to the head.

Run the control cable in as straight a line as possible, avoiding any short bends.

It should be understood that while the cable is flexible and will function smoothly even though it does not run in a straight line, nevertheless it must not be abused. Kinks should be avoided as they impair the operation of the set. This department has received a number of letters from people who maintain that the tuning cable on their auto set does not function properly. Upon investigation it was found that in their hurry to install the receiver, no consideration was given to the placement of the parts, which resulted in mechanical breakdowns.

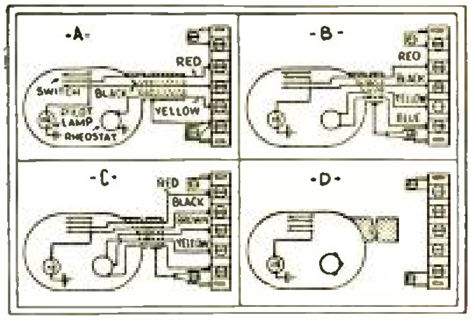


Fig. Q150B

Several circuits in which the remote tuning cable may be used. The correct one depends upon the particular cable on hand.

The next step is to loosen the large jam nut on the cable chuck. Insert the free end of the cable and its tubular housing. The weatherproof braid at this end is removed to expose the metal spring; here the housing with the weatherproof covering will not enter the chuck. If it is necessary to insert the housing so that it extends farther through the chuck, remove the covering for that distance and tighten the jam nut. Be sure that the selector knob on the control head is still turned to the stop in the clockwise direction. Turn the condensers to the extreme position (against the returning action of the spring and toward the free

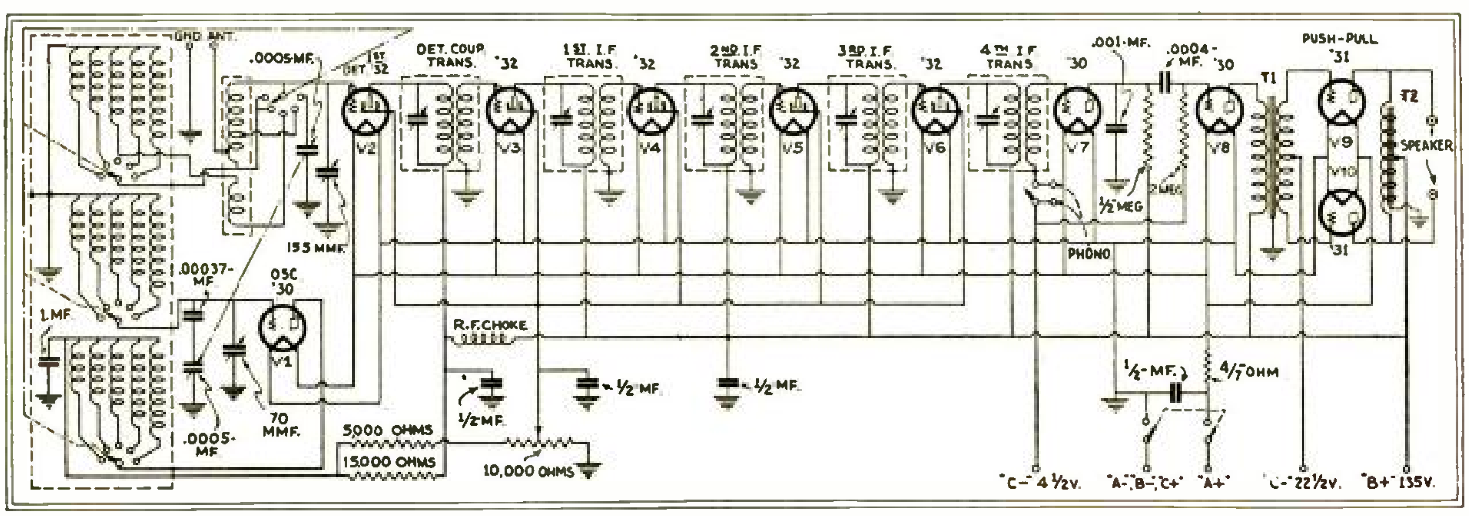


Fig. Q149

Complete schematic diagram of the Lincoln DeLuxe SW 10 All-Wave Receiver. It is battery-operated and uses the new 2-volt tubes. A three-gang switching arrangement selects the wave-band desired.

end of the control cable). Loosen the cable clamp-screw and insert the cable under the clamp washer, then tighten in place. Cut off any excess cable to prevent tangling with other parts of the receiver.

The standard cable has a length of 10 feet; a longer length may be required, up to 30 feet. This cable is to be cut off to suit the installation.

After the control head has been mounted and the control cable run to the set, mark the proper length by cutting the weatherproof covering, being sure that enough cable is allowed, to avoid sharp bends, and in no case coil the excess into short loops.

In cutting off the outside housing it is necessary, again, to be sure that the selector knob is turned full clockwise.

With a sharp, three-cornered file, mark across one of the turns of the tubular housing until it is practically severed. Then bend it slightly, back and forth, until it breaks; do not bend sharply, as in so doing permanent injury to the inner element of the cable might result.

Mount the junction box attached to the free end of the electric cable, to the vertical dash or bulkhead, and then run the volume control and battery leads to the junction box, to wire in the electric cable.

The standard automobile cartridge-type fuse rated at 5 or 10 amperes may be used for replacing the fuse in the fuse block if one is provided on the control.

The dial light may be replaced by removing the selector knob and the two screws on the sides of the control housing. Use a standard 6- to 8-V. screw-base lamp which may be procured from the factory. As a temporary measure, a 6-V. pilot-light bulb may be procured from a radio supply house.

The several circuits in which the cable may be connected, depending upon the number of wires in the particular cable required, are shown in Fig. Q.150B. At A, a 3-wire cable; B, 4-wire; C, 5-wire; and, D, arrangement for special wiring.

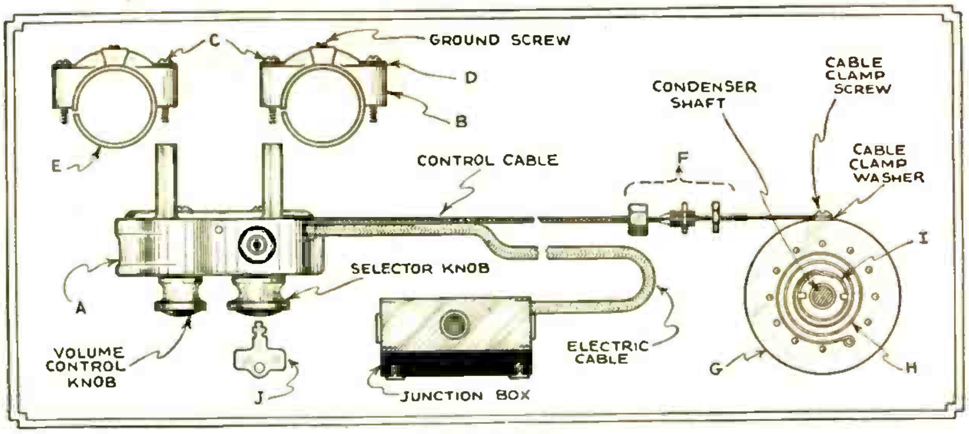


Fig. Q. 150A

Relation of parts in the Carter auto-radio control.

CROSLEY "HAPPY HOUR" AND "TENSTRIKE" ANTENNA-LESS SUPERHETERODYNE

(151) Mr. George Hartmann, Oak Forest, Ill.

(Q.1) Please show in RADIO-CRAFT the schematic circuit and service data on the new Crosley "Happy Hour" and "Tenstrike" superheterodyne receivers, which incorporate automatic volume-control action and a diode connection of the second-detector; variable-mu tubes are used.

(A.1) In Fig. Q.151 is illustrated the diagram of Crosley Model 127 Chassis, which is used in the "Happy Hour" and "Tenstrike" receivers. These were illustrated and described on page 462 of the February, 1932 issue of RADIO-CRAFT.

The average operating voltages, which are to be measured with the tubes in place, the reproducer connected, and a line potential of 117½ volts (for "220-volt" receivers, 235 volts), are given. Measure the plate and grid voltages with a high-resistance (at least 600 ohms-per-volt) D.C. meter, from plate or grid socket-contact, to emitter contact. Use a low-range A.C. meter to measure the filament voltages. Filament potential, V1 to V9, 2.4 volts; V10, 4.8 volts. Plate potential, V1, V2, V3, V4, V5, V7, 185 volts; V6, zero; V8, V9, 285 volts. Screen-grid potential, V1, V2, V4, V5, 85 volts; V8, V9, 240 volts. Control-grid potential, V1, V4, V5, 3 volts; V2, 7 volts; V3, V7, 10 volts; V8, V9, 16 volts.

Plug connections F are the field coil and "B+"; the plates (P and G) connect to the output A.F.T. Wire together terminals P, C, and S, if a phonograph pickup is not used. Second-detector V6 functions also as part of the automatic volume-control system. The shield over T1 may be rotated, after loosening the three hold-down screws, and so adjusted that the hum is reduced to a minimum; ordinarily, any slight hum will be eliminated by using output tubes of correct characteristics. The intermediate frequency is 175 kc.

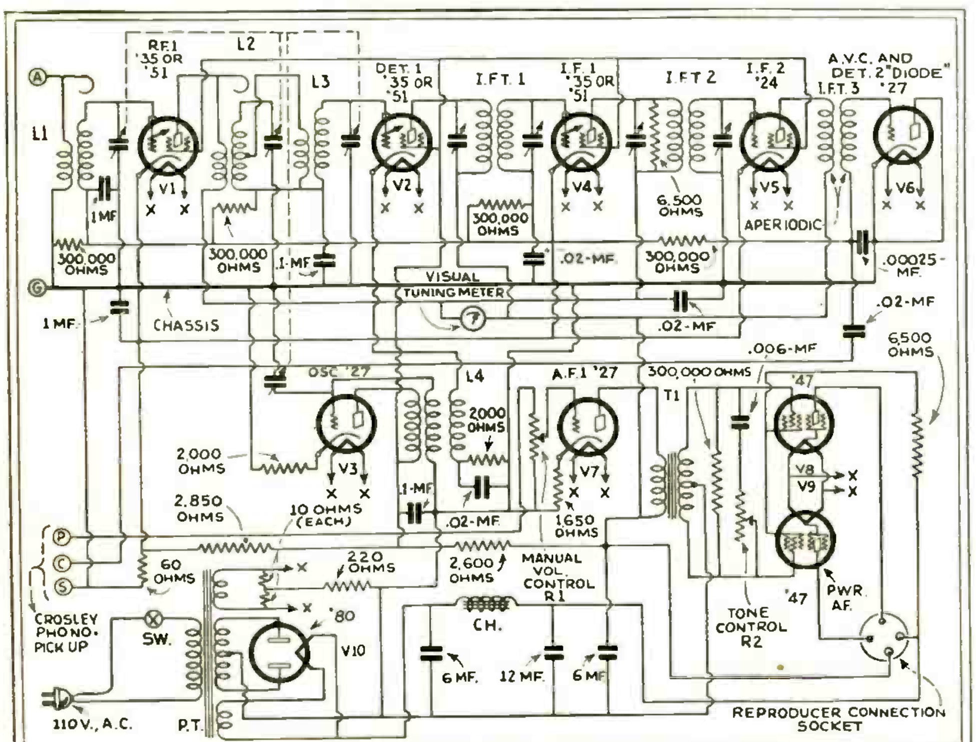


Fig. Q. 151

Crosley "Happy Hour" and "Tenstrike," Model 127 Chassis, receiver circuit. Automatic volume-control is obtained through use of a "diode"-type detector.

CIRCUIT OF 9-ELEMENT TUBE

(152) Mr. Channing K. Bowles, St. Petersburg, Fla.

(Q.1) It is believed that the "multi-element" tube developed some time ago by Loewe has been marketed in Europe. If this is the case, please show a diagram of the connections of such a tube as used in a practical receiver.

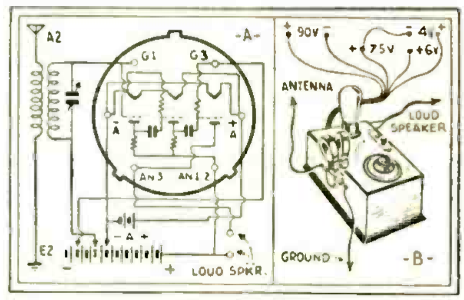
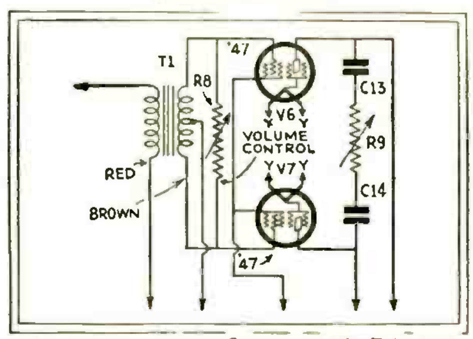


Fig. Q. 152

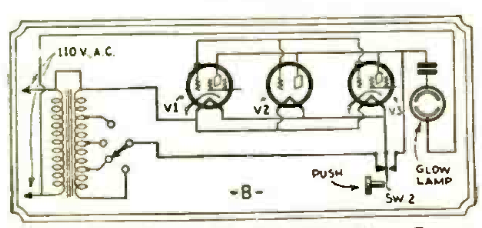
Left, circuit; and right, leads to Loewe tube.

(A.1) The tube referred to is a product of the Loewe Radio Co., Ltd., and bears the designation of Triple Valve Type 3-NFB, which is really three tubes in one envelope, each stage being resistance-capacity coupled within the tube. A compact receiver, the Type OE-333, has been built around this tube (which is not available in America), and the schematic circuit used is shown in Fig. Q.152A; and at B, the general arrangement of the receiver and tube.

CORRECTIONS



Above, Howard Data Sheet, pg. 479, Feb. 1932 RADIO-CRAFT.



Above, Fig. 4B, pg. 475, Feb. 1932 RADIO-CRAFT.

(Continued on page 551)

BOOK REVIEW

RADIO AMPLIFIERS, by Keith Henney. One of a series published by International Textbook Co., Scranton, Pa. Size 5 x 7½ ins., 175 pages, cloth, 93 illustrations. Three sub-divisions: Parts I, and II, "Radio-Frequency Amplifiers," and "Neutralized Receivers," by Keith Henney; Part III, "Superheterodyne Sets," by F. M. Gager.

The neutrodyne circuit is considered in all its phases. Also, much data on superheterodyne theory appears in the portion of the book devoted to this subject.

All-wave receivers, short-wave adapters, short-wave converters, and short-wave superheterodynes are not discussed.

Many of the statements must be taken for granted, in the hope that other volumes or later paragraphs will clarify them. It would be difficult to do otherwise, since to go into greater detail would require more space than is available in the single volume.

This book is suitable as a general reference for the subjects indicated above, since it keeps away from practical consideration, preferring to deal with theory.

(R. D. W.)

RADIO FREQUENCY ELECTRICAL MEASUREMENTS, by Hugh A. Brown. Published by McGraw Hill Book Co., New York, N. Y. 6 x 9 inches, 386 pages, cloth; 235 illustrations.

For the student who is familiar with A.C. theory and the fundamental principles of radio, this book is of invaluable aid. While a knowledge of calculus is essential in order to derive some of the formulae, the descriptions given of the methods used in making a test are so clear, concise and practical that considerable information may be obtained by disregarding the mathematics entirely.

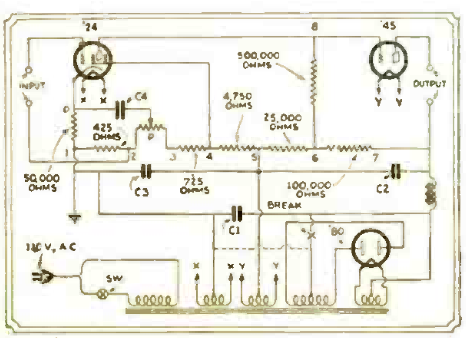
The method of procedure used in this text is perhaps a little different than that ordinarily used. First, the theory and principles of the test under discussion are derived and explained. Second, there follows a brief description of the necessary steps in the laboratory procedure or manipulation; and third, there is given a discussion of the precision attainable, precautions, and general merits of the method. The discussions following each test procedure are very interesting. The fact that a measurement made at one frequency may not be valid at another, is stressed by the author in an admirable manner.

Starting with the methods used in the measurement of capacitance, the succeeding chapters are devoted to a discussion of the measurement of inductance, resistance, frequency, and antenna constants. Chapters are also included in electromagnetic-wave measurements, thermionic-tube coefficients, electromotive force, current, power, measurement of wave form, and transmitter, receiver, and piezo-electric measurements.

For the man who is desirous of securing a text that describes the *fundamentals* of radio measurements, this book is indispensable. (L.M.)

Corrections

(*Continued from page 550*)



Above, Fig. 1, pg. 403, January 1932 RADIO-CRAFT.

"SUB" HULL IS "MIKE"-REPRODUCER

(*Continued from page 521*)

hull of the submarine but should be separated by a thin wall of water. For this reason, the diaphragms are clamped on the reproducer by capped screws which project one-quarter inch from the surface and not by flat-headed screws. An external view of the reproducer is shown in Fig. D and an internal view showing all component parts, appears in Fig. E.

Description of Apparatus

The apparatus consists of a model MG underwater reproducer, including the type SE 3489 under-sea reproducer and SE 3488 power amplifier with auxiliary batteries, announcing microphone, telephones and cable equipment. The reproducer is essentially an electrodynamic speaker of novel design, employing the use of two parallel diaphragms connected by a tube as an armature. These diaphragms are only .070-in. thick and are accurately machined from bronze metal to the end that they be non-corrosive and non-magnetic. The other component parts of the magnetic speaker are the iron magnetic casing or pole pieces, D.C. field coil and core with the A.C. coil, or speaking coil, wound thereon.

The design and arrangement of the parts are such as to withstand external hydrostatic pressures up to 150 pounds per square inch. This arrangement of the parts necessitates much care in the machining of them and their assembly. The machined dimensions of the depths of the brass casting and the diaphragms must equal the length of the armature tube. So, if the rubber gaskets maintaining water-tightness are too thick, preventing the parts coming together, there will be lost motion between the armature tube and the diaphragm. Much care is given this feature so the operation of the speaker will not suffer interference by grounds or short circuits that would be caused by salt water in the reproducer.

The type SE 3488 transmitter-receiver, the diagram of which is shown in Fig. 1, includes in its essentials one two-stage receiver-amplifier and one four-stage power amplifier having a push-pull output stage.

The large 48-volt storage battery supplies a 6-volt supply to the filaments of the SE 4374 (UX 201A) tubes and the talking microphone, and a 10-volt supply to the filaments of the UX 250 and SE 2566 (UX 210) tubes. The remaining group of batteries supplies 38 volts to the motor end of a dynamotor through the relay contacts.

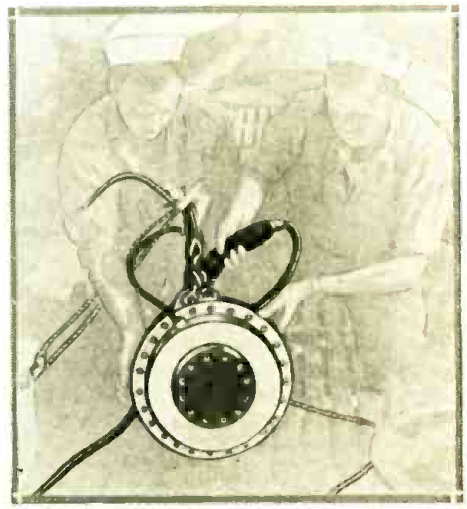


Fig. D

Close-up view of the magnetic unit.

The coils of the SE 1914 relays are energized from 20 volts through the "press-to-talk" switch in the handle of the microphone.

The 90-volt supply for the plate voltage to the type SE 4374 (UX 201A) tubes is obtained from self-contained type SE 3535 "B" batteries. A 90-volt negative grid bias for the UX 250 and 35-volt grid bias to the SE 2566 (UX 210) tubes is supplied from type SE 3535 "B" batteries used as "C" batteries. A negative 4½-volt bias for the type SE 4374 (UX 201A) tubes is obtained from a small 4½-volt "C" battery.

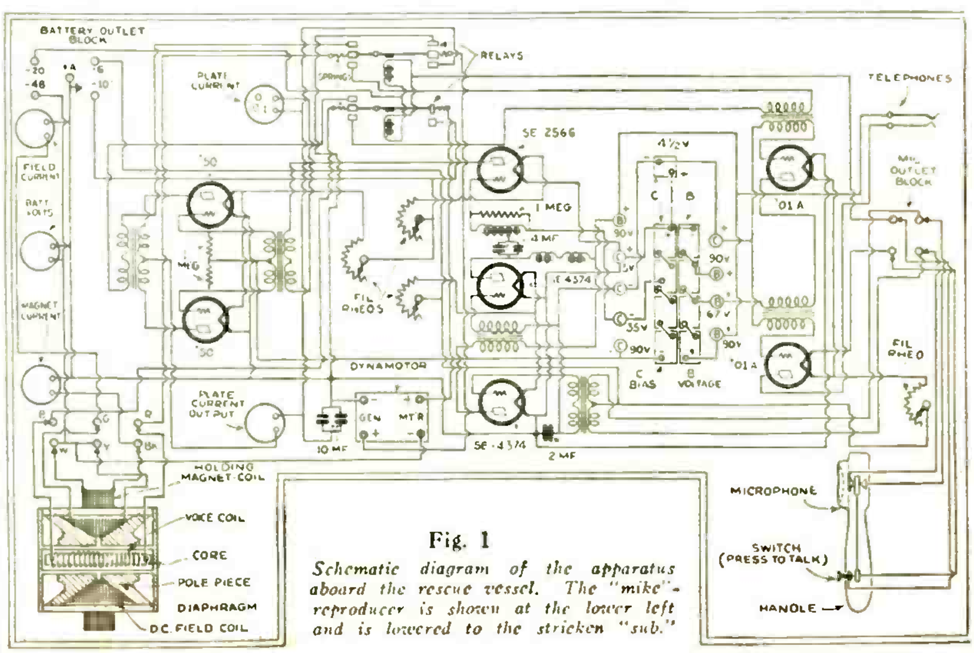


Fig. 1

Schematic diagram of the apparatus aboard the rescue vessel. The "mike"-reproducer is shown at the lower left and is lowered to the stricken "sub."

"WIRE" RECORDS

(*Continued from page 522*)

The critical temperature of any piece of steel is the temperature at which, or above which, the steel changes its physical and magnetic properties. In other words, the permeability of steel changes proportionately as the temperature exceeds its critical point, *never to return to its original value.*

A simple explanation of our system is as follows. A roll of steel wire of the proper thickness (speed and alloy will be determined by further research), traverses a heating chamber where it attains its "critical" temperature (usually between 1350 to 1450 degrees F., depending upon the alloy). It then enters the "recording chamber," which is filled with argon or some other inert gas to prevent oxidizing, as shown in Fig. 1. The wire then passes between the "recording electrodes," which are two small rollers that the wire turns.

High-frequency current, modulated by sound frequencies, passes between the electrodes, raising the temperature of the wire above its critical value in accord with the sound variations.

The wire then traverses a chamber filled with lime so that it may cool slowly back to its soft state, although its magnetic properties remain changed and vary with the sound modulations.

The wire is now ready for reproduction and, when passed between the pole pieces of a permanent magnet with a solenoid around it, will vary the field strength of the magnet as it varies in permeability or magnetic resistance.

Since this induces currents in the solenoid which are amplified into sound, we now have a permanent record on wire which can be unwound for hours from a comparatively small spool.

This is the simple theory, but many problems present themselves for solution before practical results may be obtained. For instance, let us consider for a moment how we may determine which alloy will be of the most practical use.

Choice of Steel

When we mention steel, it must be borne in mind that there are a great many types

(*Continued on page 558*)

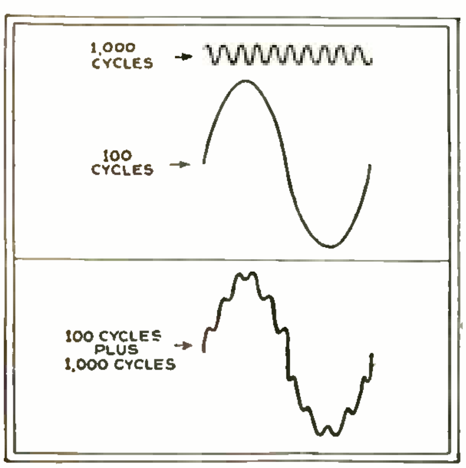


Fig. 2, above. *Two signals to be recorded*

Fig. 3, below. *Resultant signal recorded.*

POSITIVE-GRID

(Continued from page 523)

The screen-grid is connected to the control-grid externally as indicated in the diagram, but may, for special purposes, be connected in other ways. Other modes of connection will be discussed in a future issue of RADIO-CRAFT.

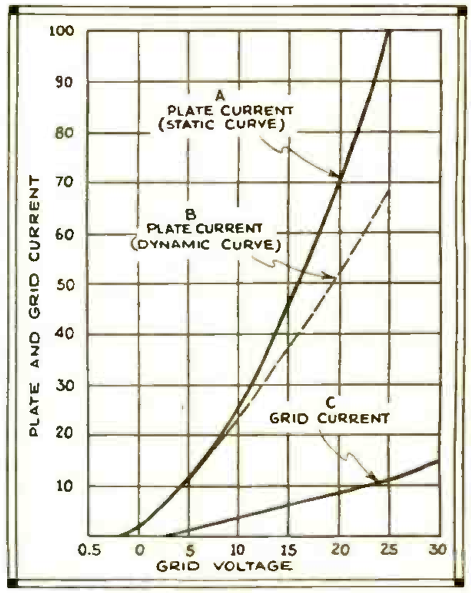


Fig. 2
Static and dynamic curves of the new tube.

The fact that this tube delivers a high output does not limit its use to public address work. This usage was designated merely because 20 watts represents a considerable output and is far more than is necessary to obtain good loud-speaker operation. For those who still desire to use the tube for radio purposes, it may be stated that a '27, coupled through a 1:1 ratio transformer, may be used. A step-up transformer should not be employed as the voltage delivered to the grid will then exceed the rated value of 35 volts, in which case excessive distortion is bound to result.

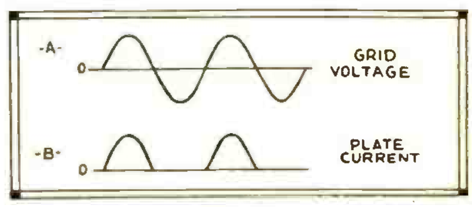


Fig. 1
Curves showing rectifying action of the tube.

(Continued on page 559)

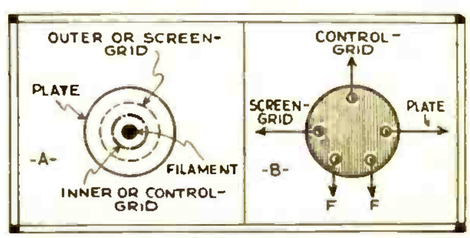


Fig. 3
Socket and element arrangement.

LATEST IN RADIO

(*Continued from page 525*)

mobile radio set, may now be eliminated by the installation of a kit of Motor Radio Suppressors. Each kit comprises the necessary suppressor units for installation in the spark-plug leads and in the main distributor lead, together with comprehensive and complete directions on the use of filter condensers and the proper adjustment of the electrical components for complete noise elimination. The kits are available for four-, six- and eight-cylinder automobiles, with the resistors packed in a neat display carton illustrated in Fig. E. Individual suppressors are available if desired..

In meeting the requirements of motor radio suppressors the units have been made moisture-proof because of impregnation with a special compound. They are shock-proof, with terminals designed to withstand severe vibration. The resistor is imbedded in a high-grade ceramic tubing which is unaffected by heat and positively non-combustible. The units have an exceptionally low capacity—less than .5-mmf.—permitting the choking out of ultra-short waves and eliminating all spark-plug noise.

These radio suppressors are produced by the International Resistance Company.

A PENTODE AND SCREEN-GRID SHORT-WAVE SET

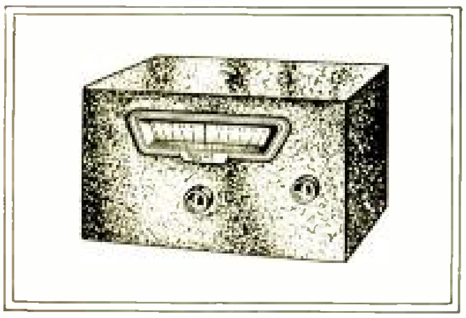


Fig. F

A screen-grid and pentode short-wave, battery-type receiver. A ratio of 5½ to 1 is obtained in the full-vision tuning dial, which does not exhibit back-lash.

NEW tubes have made their advent into the field with such rapidity, short-wave investigators have been "hard put" to realize their benefits. However, in Fig. F is illustrated an exceptionally inexpensive and effective receiver designed to utilize two of the new 2-volt tubes; one is a screen-grid detector, and the other is a pentode.

Only two controls are included in the design; one is the tuning knob, and the other is a combination volume-sensitivity control and off-on switch. Incidentally, it should be noted that the volume-sensitivity control is very effective for both 'phone and code reception.

A cadmium-plated chassis is used. Ease of tuning is obtained through the use of a micro-vernier tuning dial which is without backlash.

Battery-operated, this totally-shielded 2-tube receiver presents for headphone operation an extremely good "buy." The tuning range, by means of plug-in coils, is approximately 14 to 200 meters; an additional coil is available for the 200-550 meter range.

The receiver illustrated is the Royal, Model RP, which is manufactured by Harrison Radio Co.

ZENITH MODEL 103 14-TUBE "HYPERHETERODYNE"

THIS new Zenith set, illustrated in Fig. G, requires four variable-mu tubes, five '27's, a screen-grid, '24, two '45's, an '80 rectifier, and a voltage regulator tube.

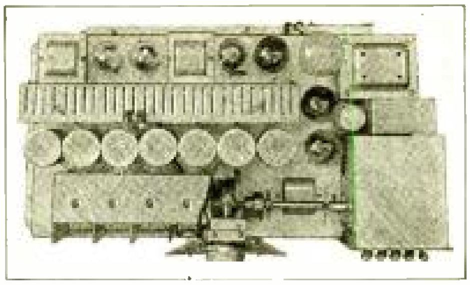


Fig. G

Chassis of the Zenith "Superheterodyne."

Outstanding are the features of a stage of push-pull voltage amplification feeding a push-pull power stage, a band-selector, automatic volume-control, phono-radio selection, tone control, and "meter tuning." Automatic tuning is available in the several cabinet combinations of the "Model 103" chassis.

A BUSINESS BOOSTER

"AT what time should I tune in the So-and-So Hour next Tuesday," is an everyday question which the Roth Press, by means of the "Radiominder," illustrated in Fig. 3, makes it convenient to answer.

Little memory-aids such as this new card, which measures 3½ by 5½ in., and is to be imprinted with the dealer's name, do much to increase business.

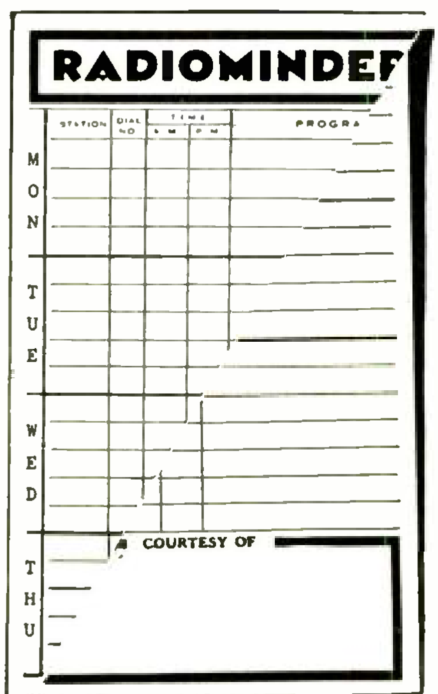


Fig. 3

A good reminder card.

☐ Radio Operating

IMPROVING AN AUTO RADIO

(Continued from page 526)

mechanical simplicity. Similarly, constant-coupling electrical systems, ideal in themselves, are impossible without the use of an untuned R.F. stage resonated at the weakest points of our response curve.

In practice, we shall resonate the primaries of our tuned stages at approximately 490 kc., the primary of our untuned coil at 850 kc., and its untuned secondary at 1200 kc. We shall also use an adjustable capacity-coupling in our tuned coils to increase the low-wave response.

The design of these transformers is shown in Fig. 2. At A is shown the tuned R.F. coil—standard in every way except that its low-inductance primary has been replaced by one consisting of 625 turns of No. 32 or 34 enameled wire wound on a ½-in. core and so placed that one end of the primary is *just even* with the ground end of the secondary without actually being within the secondary winding. In wiring these coils, the inner lead of the primary is attached to the plate, and the end of the secondary farthest from the primary, to the control-grid.

In B of Fig. 2 is shown the coil form for the untuned R.F. transformer. This is a built-up spool whose core is ⅝-in. in diameter, ¼-in. inside length, and 1½-in. outside diameter. To one end of this spool is attached a strip of bakelite projecting beyond the spool winding-space and carrying the terminals of the coil and the mounting holes. The primary of this coil is wound with 350 turns of No. 34 enameled wire. Over this is wound 160 turns of No. 32 silk-covered wire. The inside lead of the primary is attached to the plate of the 3rd R.F. tube; the outside lead of the secondary, to the detector control-grid.

Introducing Regeneration

In mounting the untuned R.F. transformer, an expedient the author tried may be attempted. In his case, he sought, by leaving the bottoms of the tuned R.F. shields open and by mounting the untuned transformer directly under the third tuned coil, to introduce a variable regeneration control. This was operated by being pivoted in an arc across the opening in the R.F. coil shield. The untuned transformer was mounted with first one end nearest the tuned R.F. coil and then the other.

In the design as finally worked out, though, this means of control was not adopted. Instead, a slight amount of regeneration was secured by so placing leads that a capacity feed-back existed in the R.F. stages between the plate and the control-grid of the tuned R.F. tubes. This capacity was small, being due to a few turns of No. 24 insulated wire wrapped around the control-grid lead and connected directly to the plate of the same tube.

Of course, there is no direct connection between the control-grid wire and that wrapped about it. Just how many turns may be used depends upon the individual case; in the set here described, only six turns were required. An alternative to this wire-wrapping stunt is the use of a midget compensator of no more than a 10-mmf. capacity maximum connected from the plate to the control-grid.

Checking Resistors

Of special note when using carbon resistors is the importance of checking the resistance values under actual operating condition. To his sorrow, the author found that some carbon resistors used at full ratings could be depended upon to change their values as much as 60%! Now, in addition to verifying the resistance values, he is careful to see that the "watts ratings" of these resistors are not exceeded.

Another point to be noted is that the plate-to-grid coupling condensers indicated in Fig. 3 are best located within the coil shield of the respective transformers whose low-wave response they improve. However, care should be taken that they do not approach too closely the coils themselves as this would reduce the latter's efficiency.

The resistance values of R2, R5, and R6 given here should be accepted only as tentative. In the author's set they worked very well; individual circuit peculiarities might make other values desirable. The set builder is advised to try several values between 200 and 1000 ohms.

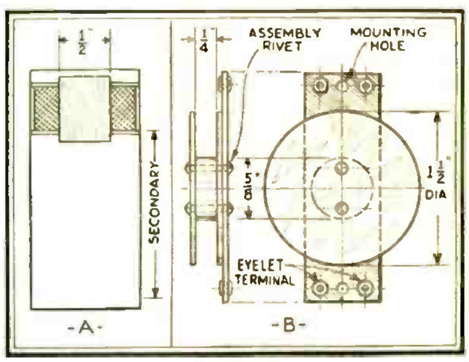


Fig. 2

Construction details of A, the tuned R.F. transformer and B, the untuned unit.

It should be kept in mind, however, that too low an R.F. control-grid bias might result in detection in the R.F. stages which, at this point, is extremely undesirable; thus, the negative bias (in the R.F. grid circuits) should always be at least one-half volt. Similarly, R7 and R8 might be experimented with to arrive at optimum values; although, if R8 is reduced much below 100,000 ohms, the loss of quality will be quite pronounced.

In "signing off," the author wishes all builders good luck and pledges all inquiries a prompt reply. He hopes sincerely that the results he has obtained with this set, which has already received stations 2000 miles away, will be exceeded by many. *Adios.*

Parts List

Three standard tuned R.F. transformers, special primary as per text, L1, L2, L3;

One untuned R.F. transformer as per text, L4;

One random-wound R.F. choke, 15 to 20 millihenries, L5;

One 0 to 50,000-ohm variable resistance, R1 (1 watt or more);

(Continued on page 570)

GRAND ISLAND

(*Continued from page 527*)

directional qualities. For this reason, another type of antenna known as the "multiple doublet" was used for high frequencies. This is similar to the ones used by the R.C.A. Communications Company at Riverhead, New York. This type of antenna consists of 39 single "doublets," spaced eight feet apart, feeding a transmission line 312 feet long, which is balanced with respect to earth. This network is supported from sixty-foot poles by triatics of steel cable. Concrete counter-weights keep the network taut at all times. (Fig. 2.)

The theory of operation of this antenna is practically the same as that of the wave antenna with the exception that the voltage is fed to the transmission line at lumped intervals. If enough doublets are used per wavelength, the effect is that of a distributed feeding and a smooth building-up of voltage is obtained. As in the wave antenna, the velocity of the electric wave on the wire is very nearly that of the space-wave, providing that the impedance of each doublet is high. This is assured by making the length of the doublets short as compared with one wavelength.

The directivity of such an antenna is such that at fifteen degrees either side of center, a constant signal will drop to one-half its value directly in line with the antenna. As the vertical pickup of this antenna is small, one of its great advantages is its freedom from local inductive interference, for this type of wave is usually vertically polarized. Also, its directive qualities are useful in suppression of regional static. Back-end signals are suppressed the same as in the wave type of antenna by hanging a proper resistance across the far end of the line. The value of the resistance in this case is 410 ohms. A special carbon resistance with terminals copper-plated to either end, is used.

The signal at the receiver end of this line is fed through a transposed vertical transmission line to a long four-wire line which is electrically balanced with respect to earth. These wires are diagonally connected so that the electrical center of each pair of wires is an identical point, so, theoretically, each line has no radio pickup. In practice, it is impossible to build a perfectly balanced line. However, the pickup is small, and what there is can be bypassed to ground through astatic shields between the coils coupling the line to the receiver. The four-wire lines are terminated in dead-ending racks, outside the main building, and are jumped to two-wire transposed lines which are connected to neon cartridge lightning-arresters just outside the windows, passed through holes in the window panes, and thence to terminating blocks on the receivers.

There are four multiple doublets, two designed for a frequency range of from 5,000 to 12,000 kc., and two from 12,000 to 23,000 kc. One pair, covering the frequency range of from 5,000 to 23,000 kc., points toward Porto Allegre, So. America, and one pair toward London, England.

In addition to the directional antennas, there are five single doublets, four of which are horizontal, and one vertical. The horizontal doublets are designed to operate below the range of the multiple doublets. The "Conrad vertical" is a high-frequency antenna. It is a vertical doublet of brass pipe offset from a 60-foot pole, by insulators. The lower part has a short T-section at the end nearest the earth. This can be shortened or lengthened to balance both sides of the doublet. This antenna is designed to intercept radio waves which are vertically polarized. These doublets are connected to the receivers, through the same type of transmission line used in connection with the multiple doublets.

A 200-foot "general purpose" antenna, Fig. 3, and a low-frequency loop, complete the antenna system. The low-frequency loop deserves special mention, inasmuch as it is probably the largest radio loop ever erected for receiving purposes. It consists of two loops crossed at right angles, each loop containing twelve strands of No. 12 wire, 250 feet long by 60 feet high. Each loop is connected inside the main instrument room by a 4-wire transmission line to the stator of a goniometer; its rotor is connected to the low-frequency receiver. (Fig. 4.)

The Radio Receivers

Both loop and receiver are designed to cover the frequency range of from 10 to 100 kc. The receiver has five stages of R.F., two of which can be thrown in or out at will. Type "210" tubes are used in the R.F. and detector stages. Two sets of coils are used, one set covering a frequency range of from 10 to 32 kc., and the other from 32 to 100 kc.

Three types of receivers are used to cover the useful radio spectrum. The low-frequency receiver has been mentioned. The intermediate-frequency receivers have four stages of tuned R.F. and cover a frequency range of from 100 to 1,500 kc., by use of three sets of coils. Type "210" tubes are also used in the R.F. and detector stages of this type of receiver. The high-frequency receivers have three stages of tuned R.F. A frequency range of from 1,500 to 30,000 kc. is made possible by use of four sets of coils. Type "236" tubes are used in the R.F. stages, and a "230" in the detector stage. The audio stages of each type of receiver are alike, namely, two stages using type "841" tubes, and an output stage using an "842."

Each receiver is connected to the standard by a No. 16 gauge copper-wire inside a 1-in. brass pipe. Isolantite beads strung on the wire keep it concentrically spaced inside the pipe. The standard energy is fed to the second R.F. stage of each receiver. This has two advantages: first, the initial stage acts as a buffer preventing the standard energy feeding out to other receivers by way of other transmission lines; second, in order to get a good beat-note between two frequencies, the energy in one must closely approximate that in the other. In case of a strong signal, the first receiver stage can be detuned, thus acting as an R.F. gain control.

"WIRE" RECORDS

(*Continued from page 553*)

of steel from which to choose. For one thing, it must be soft steel to wind easily, but it must have enough tensile strength to withstand the winding action and pull exerted upon it. Then, it should be of such composition as not to retain a magnetic field of its own once the energizing field has been removed. In this respect, it must be similar to soft iron. An idea may be obtained of how steel is alloyed and rated from the following standard table of steel ratings by the Society of Automotive Engineers:

1. Carbon steel;
2. Nickel steel;
3. Nickel-chromium steel;
4. Molybdenum steel;
5. Chromium steel;
6. Chromium-vanadium steel;
7. Tungsten steel;
8. Silico-manganese steel.

An explanation of the above list is given. A number 2340 grade of steel is nickel steel as designated by the first numeral, 2. The second numeral, 3, denotes the nickel content as 3%. The last two numerals, 40, denote the point per-cent carbon content, as 0.40%. Steel may be designated in five numerals, in which the first denotes the type as listed in the table above, the second and third the per cent of that type of alloy, and the last two, the point per-cent of carbon.

Much is known about the magnetic properties of iron and steel, but little has been tabulated along the lines that we are to work upon. We know our recording must be done above the critical temperature. Whether it be two degrees or twenty degrees above, is unimportant, for in reproduction our results will be obtained from the *relative difference* in amplitude of one sound-cycle to another.

The elements aluminum, arsenic, silicon, tin and vanadium, when used in comparatively small amounts as alloying elements, increase the maximum permeability of iron, whereas boron, carbon, nitrogen, oxygen, phosphorous, sulphur, titanium, nickel, cobalt, copper, and manganese indicate a decrease in permeability.

It is the crystalline structure that we aim to distort, with its resultant irregular spacing of the atoms. The variation of the heat above the critical temperature will vary the structure of the crystal lattice within the iron or steel wire and permanently affect its permeability.

The author succeeded in recording a 60-cycle frequency with crude and "haywire" apparatus about two years ago. This gave hope to the entire theory. That low frequencies can be recorded, we know. Anyone who is familiar with the action of an ordinary stroboscope knows there is a variation in the heat amplitude of an electric-light bulb great enough to vary the light amplitude sufficiently to actually produce a beat between the stroboscope and the 120 heat-peaks per second (for a 60-cycle line).

One may thus actually see 120 heat-alternations per second. How about the higher audio-frequencies? Let us refer back to the formula for velocity or strength of audio frequencies. From disc-recording theory, it is known that *amplitude* times *frequency* equals *velocity* or energy. Hence, a 100-cycle note of a given amplitude will have the same velocity as a 1,000-cycle note with only 1/10 the amplitude of the 100-cycle note as illustrated in Figs. 2 and 3. The 1,000-cycle note need only distort the crystalline structure of our alloy 1/10th as much as the 100-cycle note to produce the same strength. A 10,000-cycle note needs only 1/100th the amplitude of the 100-cycle note to be just as effective.

The greatest limitations of high-frequency recording on wax are the resistance of the wax to the cutter, the weight of the cutting point and the moving armature itself. In reproducing, we have the same limitations of the needle, pickup, and armature weight and reluctance.

A NEW S.-W. RECEIVER

(*Continued from page 529*)

actually there is no such gap because the oscillator covers a range sufficiently wider than 550 to 1500 kc. to eliminate it, but the gap is allowed to appear in this explanation as though it existed in order to phrase the explanation in familiar frequency terms.)

Very little of the fundamental oscillator frequency gets through tube V3, as in all rectifiers, but even if it should, it is of little importance, as a careful consideration of all possible aspects, as well as practical tests, will indicate. Likewise, the higher harmonics, though stronger, are of no importance, due to the high effective selectivity of the first-detector circuit.

The third oscillator harmonic covers the range of 3045 to 5895 kc., from which the I. F. of 465 kc. is subtracted to find the actual signal tuning range, which is 2580 to 5430 kc., or 116 to 55 meters, approximately. This third oscillator range, or third harmonic range, is utilized by the third first-detector tuning coil.

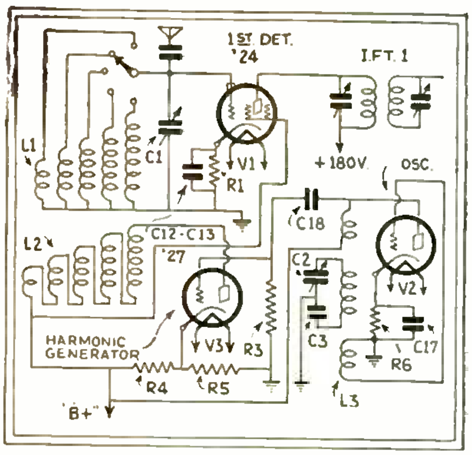


Fig. 1

Connections of the input circuit.

It is apparent from this explanation, how the last two ranges are covered by the fifth and ninth oscillator harmonics generated by tube V3, and without individually analyzing them, it may be stated that they are from approximately 65 to 32.5 and 34.5 to 17.5 meters, with, in these cases, very large overlaps between bands. (In the last case, the use of the second possible oscillator heterodyne-frequency extends the range to 16.5 meters.)

Upon consideration, the whole idea is seen to be almost childishly simple, yet its conception is so new that basic patent applications have been filed on the system.

The circuit of the actual receiver, illustrated in Fig. 2 and also by the photograph, deviates from Fig. 1 only to the extent necessary for constructional reasons, such as the method of changing antenna connections from broadcast to short-wave bands, etc.

One of the great advantages of the system is that the tuning dial can be divided into five accurately-calibrated sections, making the finding of stations quite easy. This calibration is quite accurate, sufficient to enable easy hunting in a narrow range for a new station, since once the dial is set to the range indicated by the selector switch, it is only necessary to adjust the trimmer knob for greatest noise to obtain resonance, when hunting is done by adjusting both knobs simultaneously.

Once found, the logging of the oscillator dial, which is quite sharp, while the antenna tuning knob is not nearly so sharp, is absolutely dependable, and stations will always be found at the same dial setting. While the selectivity on all waves is absolute 10 kc., the short-wave tuning is delightfully smooth, easy and simple as compared to previous short-wave superheterodynes, in some measure accounted for by the very smooth, positive high-reduction vernier dial.

The amplitudes of successive harmonics developed by an oscillator or harmonic generator fall off as the harmonics increase, as is well known, and the question will arise as to how, in this system, the ninth harmonic can be strong enough to do a good heterodyning job, since it is much weaker than the second harmonic. The answer is simple.

In terms of percentage, the resonance-curve shapes of all four first-detector short-wave circuits are substantially the same, while the distance away from resonance of these circuits that the oscillator must work is constant at 46 kc. This means that the percentage difference between oscillator and station frequencies decreases with increasing frequency, or that the harmonic generator sees an increasing impedance in the first-detector circuit, across which it must develop the heterodyne voltage, as the frequency increases. The net result is a nice practical balance, whereby as the used harmonics step up and decrease in amplitude, their task is made correspondingly simpler. In actual practice, therefore, the decrease in amplitude of successive harmonics is so nicely compensated for that it is of no practical consequence.

THE POSITIVE-GRID TUBE

(*Continued from page 554*)

Class "B" amplification has, for some unknown reason, been entirely neglected in radio receiving circuits. In transmitting equipment, the harmonics generated are eliminated by means of filters. In receiving circuits, no filters are necessary because the load impedance is adjusted for minimum distortion, in this case 10 per cent with a 1250-ohm load. When this tube becomes available, a new field will be opened to experimenters. The trend in modern design is toward greater output, and the author believes that this may be economically secured only with a tube such as described in this article. Additional data will be published in RADIO-CRAFT.

"SCREEN-GRID 6"

(*Continued from page 530*)

The case for the chassis is made of No. 18 gauge sheet iron. The chassis is mounted in the case and the latter is fastened below the instrument board, at the right side, using three long bolts. The speaker is also mounted in back of the instrument board, as indicated in the sketch. The remote-control unit is fastened to the steering column. The "B" and "C" batteries are mounted in a specially constructed battery box, made of No. 16 gauge sheet iron. This box is mounted beneath the floor board, near the storage battery box. The antenna is fastened below the running board and the silencer kit (described in past issues of RADIO-CRAFT) is connected in the car's ignition circuit, in accordance with the directions given with the kit. The speaker field is connected to the storage battery and the set is ready for operation. Ample volume is obtainable from the receiver, provided it is properly constructed and installed.

List of Parts

One Cardwell triple variable condenser, type 317-C shielded, .00035-mf. each section, 10, 13, 19;
Four Aerovox bypass condensers, type 207, 1-mf. each; 8, 9A, 15, 21;
One Aerovox mica condenser, type 1460, .001-mf., 23;
One Aerovox mica condenser, type 1450, .01-mf., 26;
Two Trutest R.F. chokes, type R.F. 64, 3, 24;
One Electrad volume control, type RI 202, 7, with toggle switch 37;
One Electrad 100-ohm flexible grid resistor, 6;
One Electrad 5000-ohm flexible grid resistor, 9B;
Three Conoid shielded R.F. coils, 9, 12, 18;
One Amperite, No. 227 with m't'g, 31A;
One Durham Powerohm metallized resistor, type M.F. 4, 6000 ohms, 16;
One Durham Powerohm metallized resistor, type M.F. 4, 10,000 ohms, 17;
One Durham Powerohm metallized resistor, type M.F. 4, 50,000 ohms, 22;
One Durham Powerohm metallized resistor, type M.F. 4, 250,000 ohms, 25;
One Durham Powerohm metallized resistor, type M.F. 4, 500,000 ohms, 27;
Two pairs twin binding posts, type SA-185, 1 and 2, 30 and 31;
Seven wafer-type UY sockets, No. SA-176, 5, 11, 14, 20, 28, 29 and socket for cable plug;
One 5-prong National plug, soft rubber, No. 5: 32, 33, 34, 35, 36;
One No. 12 gauge aluminum chassis, 6 ins. x 12½ ins. high;
Three Arcturus auto screen-grid tubes, type 136; 5, 11, 14;
One Arcturus auto detector tube, type 137; 20;
Two Arcturus auto pentode tubes, type 138; 28, 29;
One dial light, 5-volt, 4;
One sheet iron case for chassis;
One Wright-DeCoster Vehicle speaker, consisting of Vehicle cabinet with Infant model dynamic "vehicle" chassis, equipped

(*Continued on page 564*)

AN INEXPENSIVE TEST PANEL

(*Continued from page 533*)

lected and their resistances may be obtained in a number of ways.

They may be secured from the manufacturer of the meters by stating the model and range of meter and the voltages which you expect from them. R2 is usually included with the purchase of the meter. Multiplier resistors which increase the range of a voltmeter may be calculated from the following formula:

$$R1 = \frac{R(E1 - E)}{E}$$

where,

R1 = Multiplier resistor,

R = Internal resistance of meter,

E1 = Highest reading of the meter desired, and

E = Present reading of the meter.

The value of the various resistors may be determined by the following procedure. Place a variable wire-wound resistor of 10,000 ohms or larger in the circuit where resistor R4 would ordinarily be and adjust its control so that its total resistance is in the circuit; then across jack pins labeled 90 volts, place 90 volts of "B" batteries and gradually decrease the resistance until the indicating hand of the meter lies directly over the last scale division on the right of the scale, measure the resistance of the variable resistance which is in the circuit with the ohmmeter and replace with a fixed resistance equal to this value permanently in the circuit. After R4 is placed in the circuit, the resistor R5 may be found in the same manner using the 90 volts of "B" batteries across the 450-volt jack pins and adjusting the resistance until the hand of the meter lies directly over the .9 division on the 4.5-volt scale. Measure the resistance as before and substitute a fixed resistor of the same value as the variable unit.

The resistance of R1 and R2 may be found by the same procedure except that the A.C. 110-volt line is used instead of the "B" batteries. The variable resistance substituted for R2 is adjusted first until the line voltage reads directly on the 140-volt scale of the meter. After finding the value of R2, it is then possible to use the same method in determining the value of resistor R1; adjusting the resistance until the pointer of the meter lies directly over the 22nd division on the 140-volt scale, providing the line voltage is 110 volts. If the line voltage is other than 110, the reading should be equal to the line voltage divided by 5, for the 700 range.

The multiplier resistor for the 0-50,000 ohmmeter scale is found by placing the variable resistor in the circuit in place of R3, short-circuiting the jack pins HR, HR and then decreasing the resistance until the pointer of the ohmmeter reads full scale. Replace the variable resistor with a fixed resistor of value equal to the variable resistor.

Construction of the Panel

Fig. 2 shows a suggested panel layout for constructing the test board, giving the location of the various parts. To eliminate the expense of engraving the panel and still give the instrument a finished appearance, the majority of the jack pins are mounted in the center of a 1 x 12 in. strip of white cardboard, the remainder of the pin jacks are placed directly above this strip, except the capacity meter jacks which are located between the two meters. The various jacks are identified by means of lettering placed on the cardboard.

The rear of the panel may be arranged according to the parts on hand. All resistors and condensers except the 1-mf. condensers C2, C2 are self-supported by their bus-wire connections. The battery cable may be of such length as to permit the batteries to be placed under the work bench if so desired.

Fig. 3 shows the construction of test leads which are very serviceable as well as economical. From a section of windshield-wiper rubber hose, cut two lengths 5 ins.

(*Continued on page 563*)

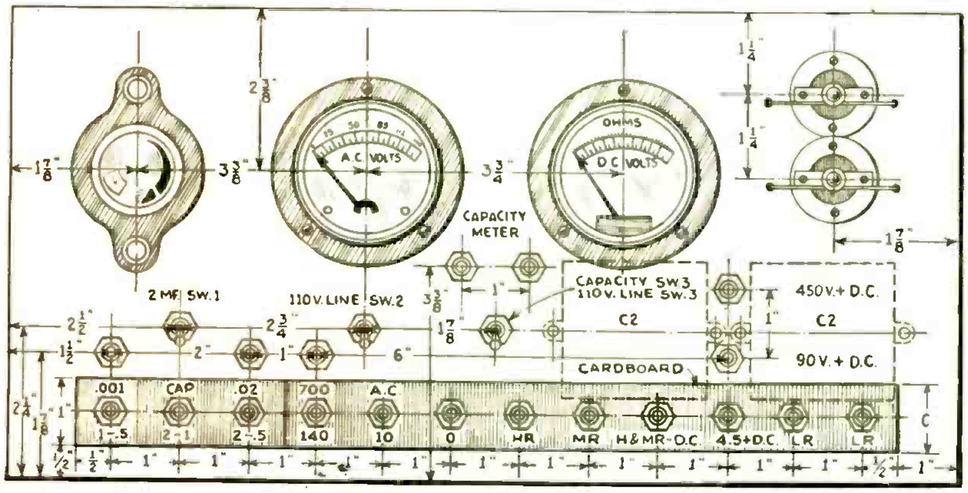


Fig. 2

The layout above shows the location of all the parts used in the test panel. The two pilot lights at the right are for measuring small resistors, while the large one at the left is for indicating when the power supply is connected. All dimensions are given for the convenience of constructors.

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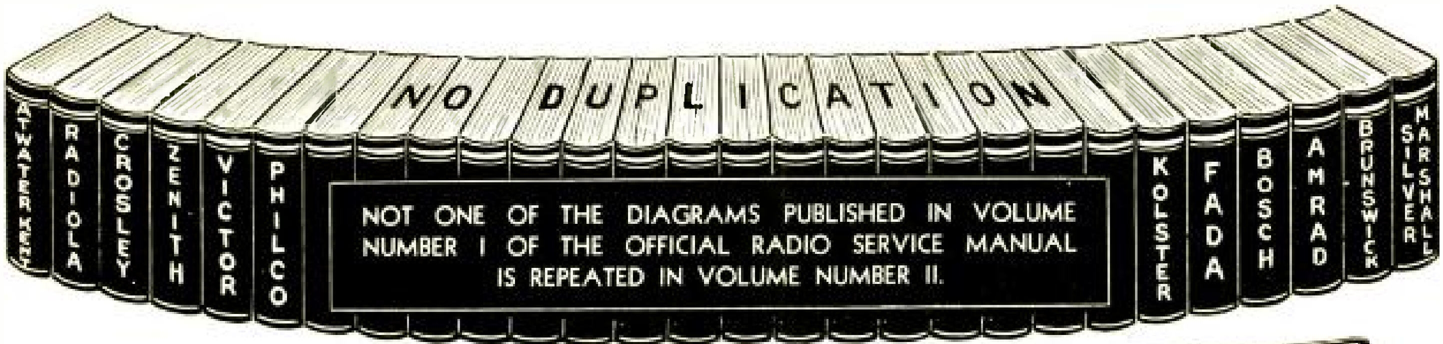

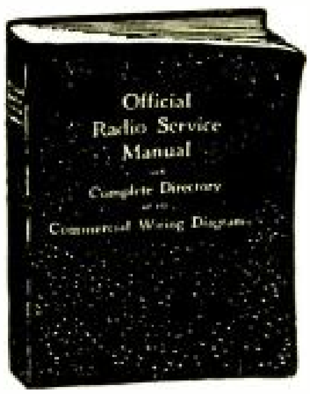

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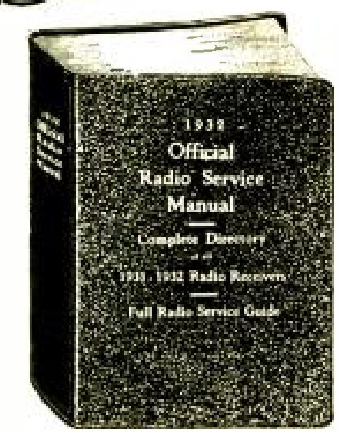

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ELECTROLYTIC VARIABLE CONDENSER

(*Continued from page* 531)

and should be held there until the current has decreased to a value of approximately 3 or 4 milliamperes.

After the completion of the forming process, there will be noticed that a greenish-gray film has been placed on the rotor assembly. The condenser should now be assembled, the rotor being placed in its copper can. A solution consisting of ½-pt. of distilled water, 2 ozs. of boric acid, ½-oz. of borax, and ⅛-pt. of pure glycerin, mixed while hot, should now be poured in to a height so that the plates are just covered, as shown in Figs. 3 and 4. The completed condenser should be placed again on a source of high voltage and the leakage current allowed to decrease. This aging process may be done either on a power pack, battery, or a generator.

The capacity of the finished condenser will, of course, be dependent upon the area of the rotor plates. This has been left to the judgment of the experimenter and he can make the condenser to suit his needs. It will be possible to obtain approximately 1 mf. for every 20 sq. ins. of surface area on the rotor plates. The positive terminal to the condenser will be attached to the shaft and the negative terminal to the can.

AN INEXPENSIVE TEST PANEL

(*Continued from page* 561)

and 1¼ ins. long and slip these over a 5-ft. length of rubber-covered wire to which is soldered two phone-cord tips. At the back of the tips on the wire, place a coating of rubber tire-cement. Before the cement is dry, slip the rubber tubes over the phone tips as shown in the drawing. In addition to a pair of the above described leads, one should have a pair of leads having the small rubber tubes at one end and small battery clips on the other, and a pair of leads with clips on both ends.

Parts Required

One inexpensive A.C. double-range voltmeter, 0-10-140 volts;
One resistor to increase the 10-volt range to 140 volts A.C., R2;
One resistor to increase the 140-volt range to 700 volts A.C., R1;
One inexpensive 4.5-volt, 10,000-ohm resistance meter;
One resistor to increase the ohmmeter range to 50,000 ohms, R3;
One resistor to increase the 4.5-volt range to 90 volts D.C., R4;
One resistor to increase the 90-volt range to 450 volts D.C., R5;
Three Toggle switches, S1, S2, S3;
Two miniature flashlight porcelain receptacles;
One 1.25-volt flashlight bulb;
One 2.2-volt flashlight bulb;
Nineteen phone tip jacks;
One .001-mf. condenser, C1;
Two 1-mf. condensers, C2;
One .002-mf. condenser, C3;
One strip white cardboard 1 x 12 ins.;
One rubber panel 7 x 14 ins.;
One 110-volt porcelain receptacle;
One roll hook-up wire;
Five ft. lamp cord;
One 110-volt plug.

REPAIRING CONES

(*Continued from page* 534)

removed and the pattern cut out with sharp scissors (small surgical scissors are very good) *on the line.*

It may be impossible to trace the voice-coil circle accurately due to raggedness of the surface. In this case, draw in a circle using a compass with a radius a hair's breadth larger than that of the voice-coil circle, as measured on the flattened pattern. If the pinholes on the seam have been made in a straight line, it will only be necessary to extend the lines passing through the pinholes till they meet. This point marks the center if the lines have been accurately drawn. Otherwise, locate the center point by trial, using the compass.

To make the flange on the small end of the cone, a series of radial cuts must be made in the pattern, reaching just beyond the voice-coil circle. The square stubs so produced are now bent so as just to include the pencil line of the circle in the bend, allowing in this way for the width of the paper which makes the flange. A perfect fit is thus assured the voice coil.

After collodion cement is applied to the seam edges, these are put together to make coincide the pinholes through which thumb tacks are passed into a flat board. The seam is thus held tightly against the board until dry. When dry, the cone should be placed on a flat surface, large diameter downward, and a small book placed on top of the cone until the paper sets.

The Voice-Coil Tube

To make a voice coil, the paper used must have straight edges, an absolutely even surface and uniform quality. The two-inch paper used in adding machines fills the bill in all particulars and is just wide enough.

The paper must be wound on a form of some kind. In many cases the pole of the speaker field can be used. Where this is possible, experimentally wind this paper ribbon tightly upon the pole until it takes up nearly half the space between the pole and the steel collar surrounding it. The diameter of the paper ribbon is then that of the voice coil to be made. We say "nearly half the space," because room must be allowed for the voice-coil wire.

Now, slide the paper tube off the pole piece and unwind it *from the inside* until just two layers of paper are left to form the tube. Nick the paper at this point and then unwind the rest of the tube. Cut the

(*Continued on page* 564)

"SCREEN-GRID 6"

(*Continued from page 560*)

with 7500-ohm impedance output transformer;
One Ward De-Luxe car antenna;
One Ward silencer kit;
One Premier remote-control unit;
Three Burgess special automobile "B" batteries, type 2305, 45-volt;
Three Burgess tapped "C" batteries, 4½-volt, type 2370;
One sheet iron battery case;
One roll, Corwico Braidite hook-up wire, solid core;
One coil, Corwico shielded Braidite.

REPAIRING CONES

(*Continued from page 563*)

paper straight across at the point where nicked. These two pieces give us the exact dimensions for cutting two new strips which are wrapped carefully around the pole in the proper order; first the "filler" strip and then the "coil" strip, using thin cement in strategic places to keep each from unwinding. Of course, cement must not be put between the separate strips.

While the paper is on the mandrel or pole piece the second time, the wire can be wound on the form according to the position and number of turns of the old voice coil. The same numbered wire or a close approximation to it should, of course, be used. Extra wire should be allowed for leads to the proper terminals within the speaker.

Collodion lightly applied to the coil ends will keep the wire from unwinding and rattling. (Collodion applied over the entire surface of the voice coil tends to flake loose and produce buzzes at high frequencies, and should therefore be applied sparingly.) If too long, the voice-coil form must, of course, be cut down and can be quite easily done with small surgical scissors. The winding helps the form to retain its circular shape but the real secret lies in making the joints of the core-form neatly and with a minimum of cement or "dope." The form may be dipped in hot paraffin which serves further to stiffen the coil and protect it against moisture.

Reassembly

The sequence of reassembling will differ according to the type of speaker so that this must be left to the judgment of the repairman. Certain general requisites apply to all speakers, however. The cone and voice coil must be centered with regard to frame and field pole, and the latter must not touch the coil. The leads from the voice coil must be "doped" onto the cone and "spiders" to prevent vibration, since even a half-inch of loose lead-wire may introduce an unpleasant buzz.

The problem of repairing cones is one that does not seem to receive much attention. While Service Men in large cities may be in a position to obtain replacements in a relatively short time, those located in the more sparsely settled sections of the country must develop methods of their own to effect speedy repairs.

"SHORT"-CHECKERS

(*Continued from page 535*)

and the tube under test. The voltage values specified allow a rise in line voltage to 125 volts before tubes or dial lights are operated at maximum allowable voltage.

The transformer used for this purpose should be capable of supplying about 25 watts on the 4.5-volt winding and an additional 10 watts on the 10.5-volt tap, making a total primary wattage rating of around 45 to 50 watts allowing for loss in the transformer. This transformer was designed and wound for the conditions enumerated, but constructional details are beyond the scope of this article.

Some Service Men will be able to design their own transformers, others will have them wound, and still others will possibly use transformers with higher voltages, such as two 5-volt or one 5- and one 7½-volt secondary, and will make necessary changes in the resistance network to accommodate the circuit to changes in voltage, the change in resistor values depending on the voltage drop required. Any added resistance must be placed just *before* or *after* the present resistor-and-lamp combination, however, and not added to the present resistor shunted by the lamp, as these values have been properly proportioned for the current flowing and the type of dial light used. Be sure to use the types of dial lights specified in order to get correct results.

It is evident by now that the writer is somewhat partial to the use of the neon lamp for short-checking and is also in favor of checking tubes "hot," though due mention has been made of other methods. Checking for shorts with the tubes "hot" introduces some peculiar phenomena of which mention has already been made, but it is a more accurate check when properly used and understood, even though somewhat more involved or complicated than a "cold" test. Suit yourself, as either is very good.

OPERATING NOTES

(*Continued from page 536*)

control is set for bass reproduction, is received on the Atwater Kent Models 83 and 85. After a great deal of testing and checking, *made more difficult by the fact that the schematic diagrams were unavailable* (these circuits appear in the "Official Radio Service Manual, Vol. II."—*Tech. Ed.*), the trouble was finally traced to an open choke in the pentode control-grid circuit. (This choke connects to one of the leads from the tone-control switch.) What role this choke plays is difficult to state for, when it was shorted out, the receiver performed as it had never done before. This portion of the Models 83 and 85 is illustrated in Fig. 4.

The alignment condensers of these two receivers are located on top of the coils, beneath the coil shields, and to attempt an adjustment of them would necessitate removal of the shields, a procedure that does not make for accuracy. As the shield cans are all of the same size, a duplicate may be secured for service purposes with several holes drilled in the top to permit the insertion of the adjusting screw-driver. When alignment is necessary, this shield can is to be substituted for the one ordinarily used.

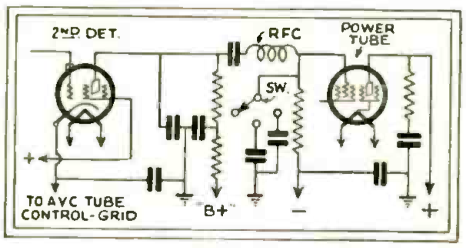

Fig. 4

The detector circuit showing the location of the RFC which caused trouble.

DISSECTING A SET TESTER

(*Continued from page 537*)

Although the construction of a tester with push-button switches is more expensive than with a multi-contact rotary switch, the Diagnometer was designed with sturdily-constructed and heavily-insulated push-button switches because of the more rapid and safer operation assured. The push buttons are clearly identified by permanent lettering adjacent to the buttons on the panel.

Push-Button Circuit Control

Depressing a "Volts" push-button connects the "Multi-Meter" in series with the proper multiplier resistors as determined by the "Scale Selector" setting, across the radio tube circuit corresponding to the panel identification of the button. Depressing a "Mils." push-button places the meter, with the proper paralleled shunt as determined by the "Scale Selector" setting, in series with the radio tube circuit corresponding to the panel identification of the button.

The "Sp. Ch. Grid Volts" and the "Space Charge Mils." push-buttons are employed for testing R.F. pentode potentials and currents, and for tests of circuits which employ four-element screen-grid tubes as "space-charge" amplifiers. For all potential measurements, a toggle switch is connected to one side of the "Multi-Meter" and arranged so that the control-grid and anode measurements may be made either from the cathode or from the negative filament terminals of tube sockets, making the Diagnometer adaptable for all pentode tests, as well as all other tests. Two analyzing sockets are provided for the accommodation of five- and four-prong tubes.

In forthcoming issues of Radio-Craft there will be published additional data concerning this interesting tester. Finally, when all the component parts have been described, it might be interesting to attempt to analyze the complete circuit that was published in the January issue of Radio-Craft.

ELECTRIC CODE

(Continued from page 539)

instalments due upon their sets.

For a period of three years, no aerials were permitted upon roofs by these owners. Tenants were denied access to roofs, except as fire exits and during daylight hours for the purpose of using the clothes-line racks.

By doing away with the experimenting by tenants with aerials upon roofs, all persons seen upon the roofs after daytime hours were subject to arrest and police interrogation, resulting in greatly reducing the number of burglaries and petty-theft cases reported by tenants in these buildings. This had been an important detail in connection with their houses and, with plenty of tenants available for all their apartments, the owners made no exceptions to their aerial ban; tenants feeling that this ruling was oppressive, were compelled to move.

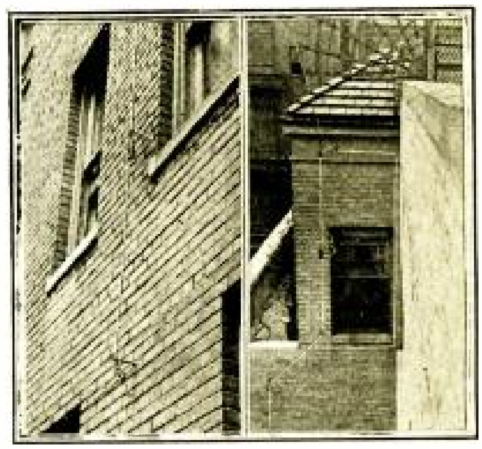

Fig. C. *A Multicoupler installation.*
Fig. D. *A neat cornice-wiring job.*

Enter the Depression

Conditions in the real-estate business have changed in the last two years, however, and the scarcity of apartments with plenty of takers gave way to a surplus of apartments with tenants demanding and receiving all sorts of improvements in apartments as a matter of course. Radio entertainment had also reached the level where it played a very important part in the life of the average person, and tenants were loath to accept the noisy background present with radio programs received upon an indoor aerial. Superintendents found it increasingly difficult to rent apartments, and the writers, called in as consulting engineers, suggested aerials be installed at the expense of the owners.

The Antenaplex system was used on some of the buildings while the Multicoupler system was used on others. Both gave very good reception and, the material used in both systems being approved by the National Electrical Code, certificates were obtained without any delay as soon as the jobs were finished. It is well to remember that the National Electrical Code covers all electrical merchandise, as well as the manner in which merchandise is to be used; insurance rates on buildings will be raised for violations reading "use of unapproved material," the same as when violations are reported for unapproved workmanship.

Fig. B shows an aerial installation similar to the one causing the plaster shower. Note that the vent pipe, being situated at the end of the roof, cannot very well be secured at the top with guy wires in all four directions and must depend upon its own rigidity to maintain an erect position. With the pipe and board attached to it acting as the lever, and the pull of the aerials acting as the applied force, the edge of the roof becomes a fulcrum of a lever of the first class, as the high-school physics teacher explained to us years ago.

Types of Aerial Systems

Apartment-house aerials consist of two types: one uses a vacuum-tube R.F. amplifier to amplify, without discrimination, all radio waves (within certain limits) impinging upon the aerial and capable of supplying enough signal energy for low-noise-level operation of 250 radios; the second type is a less-expensive arrangement supplying up to 30 apartments with each aerial and without using any vacuum tubes. The Antenaplex system is one of the foremost in installations of the first type while the Multicoupler is a leader in systems without tube amplifiers.

In the Antenaplex system, it was found best to install the untuned R.F. amplifier in the penthouses containing the heads of the stairways. The lead-in from the aerial is brought to this amplifier and associated apparatus, and from these, risers are dropped for each tier of apartments. In several houses, it was possible to use chimneys, no longer in use as such, for ducts in which to drop the risers, thus avoiding the necessity of strapping. In other cases, the lead-covered cable used for the riser, known as "Cabloy," was fished down partitions, strapped down dumb-waiter shafts, and sometimes, the speaking tubes in the older buildings proved ideal riser conduits.

In the last-named case, it was usually necessary to open the floor in the apartment on the first floor above street level, owing to there being offsets in the speaking-tube lines due to the fact that the room arrangement on the ground floor differed from that of the upper floors, due to the existence of the main hallway.

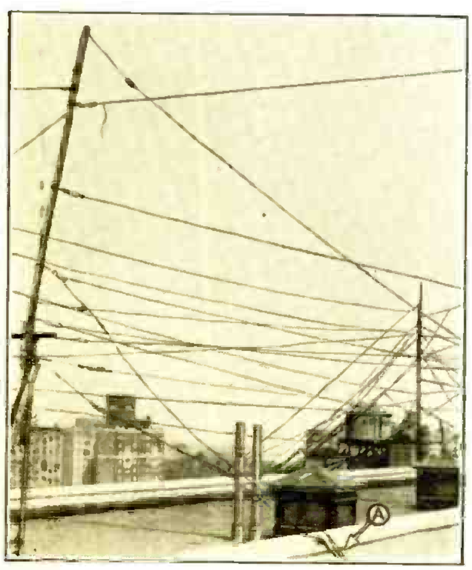

Fig. E

The poor work at A may account for the poor reception that is being received.

With the Multicoupler system, nearly all installations were installed outside the building and the risers fastened to the brickwork. A mast shaped like an inverted "L" was used to support the aerial with the Multicoupler system, and the lead-in dropped vertically downward from the aerial span; this was made possible by turning the mast so the short section of the "L" pointed away from the building.

A typical Multicoupler lead-in is shown in Fig. C. No "human fly" type of mechanic is necessary as all fastening may be done from the windows. It also shows the latest type of Multicoupler unit, one of which is required for each apartment supplied from the aerial.

Fig. D shows how the lead-in is kept away from the edge of the roof coping. The aerial mast being shaped like a davit that holds life boats in place upon a steamship, the riser is thus so fastened that it cannot rub against the coping. Compare this with the lead-in at A, Fig. E, stretched over the edge of the coping and destined to cause plenty of crashes and "static" in the receiver it supplies with energy.

In all these aerial systems, much grief and quantities of bent nails may be avoided by fastening to masonry with the proper plugs. These are usually cylinders of wood, metal, and jute, designed to be placed in holes previously drilled for them in the masonry with a star drill and a hammer. If the plug fits the hole, that is, if the hole has not been made with too great a diameter, driving a screw into the plug will cause the plug to exert pressure against the circumference of the hole and resist pulling out. For aerials, the jute plug known as the rawl plug, does very nicely.

Costing slightly over one cent each and requiring a hole small enough to be drilled in the plaster between the bricks in from 10 to 30 seconds, a No. 10 rawl plug with a 1-in. No. 10 wood-screw will sustain a steady pull of one hundred pounds.

In hammering or using other tools while leaning out of windows, it is good practice to tie the hammer and drill to the wrists.

Like all good things, both the Antenaplex and the Multicoupler systems have been copied. Bootleg systems, with no provision to prevent coupling between receivers, and consisting of a roof aerial, lead-in, and plates for aerial and ground in the apartments, are to be found in many buildings—some new, where "radio engineers" have convinced architects and builders of the merit of their systems. When a plurality of receivers are connected to these, however, reception is terrible and outside individual aerials are demanded by tenants. The further harm done by these systems is that, any particular system being a failure, landlords become convinced that all apartment-house systems are a failure and permit the forest of masts and tangled spans and lead-ins to again deface roofs.

Radio Service Men will be better off by using and installing approved antenna installations than by asking landlords to pay for their experiments in installing their own conceptions of apartment house systems.

KINKS

(*Continued from page 546*)

This unit is housed in a small container and sold to the customer for $2.50. After a free demonstration on a bad night, the customer will always buy this device.

Hum Eliminator

Many of the early type as well as some of the later model A.C. sets had a very bad hum. Different methods have been tried to combat this evil but only one device seems to be the panacea for all our hum troubles. This is an adaptation of the hum-bucking unit designed by Miessner and used by Loftin-White in their amplifier. Almost everybody knows what a success it has been in the above units. It is simple to construct and adjust. It promises an inviting field of revenue for the wide-awake Service Man.

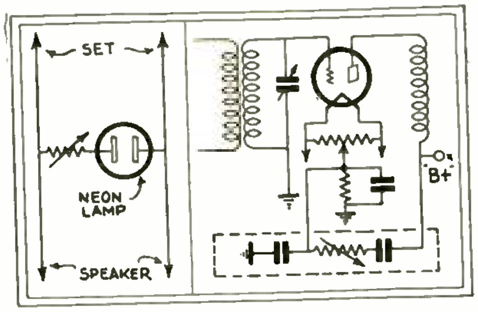

Fig. 2, left. *Circuit of the static reducer.*
Fig. 3, right. *Hum-control circuit.*

As seen in Figs. 3 and 4, it consists of two .5-mf. condensers of 400-volt rating and a 5000-ohm variable resistor. When installed, it is only necessary to turn the arm of the resistance to a point where no hum is heard.

This hum-bucker has been used with success in such sets as the Majestic "70" and "90," Temple "8-80," Victor "RE-32" and RCA "16," "18," "33" and "60." It should be connected in the last radio-frequency stage.

Tone Control

In spite of the great popularity of dynamic speakers, many sets are still found employing the magnetic speaker. Very often the owner complains of insufficient bass and a superabundance of tones in the middle register. This situation can be remedied by the use of a device called the equalizer.

The constants for the trap for use with magnetic speakers are one .1-mf. condenser, one 80-mh. choke such as Samson, and a 0-50,000-ohm resistor. The resistor is adjusted until a pleasing response is obtained. The schematic is shown in Fig. 5.

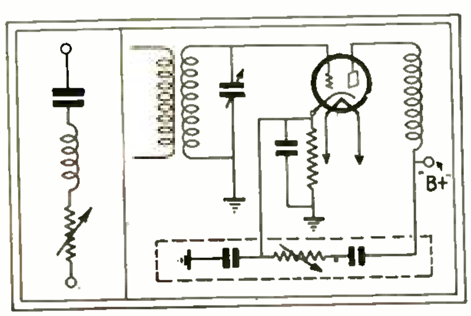

Fig. 4, right. *Another hum-control connection.*
Fig. 5, left. *Tone-control unit.*

R. F. COIL DESIGN

(*Continued from page 545*)

A cross-section of the coil arrangement is illustrated in Fig. 5.

Screen-Grid Tubes

In this discussion, we promised to consider the problems of designing primary coils for screen-grid, variable-mu, and R.F. pentode tubes. Up to this time, we have considered them as a group as the coil requirements are very similar in each case. There are, however, some peculiarities which must be considered for each type.

In the screen-grid tubes with which we are most familiar, the shielding grid is placed between the control-grid and the plate in order to remove those electrons which make up the well-known "space charge." This shield grid reduces the internal capacity to a very small value, but it does not entirely eliminate it. Consequently, if the signal voltage is stepped up to a sufficiently large value, some current will return over this internal tube capacity and start the tube to oscillate. Also, as explained before, it is extremely difficult to shield the external circuits in the space permitted by present-day commercial design. Therefore, the amplification per stage is effectively limited, even when the frequency factor is removed.

For the above reasons, it is well not to try to obtain too much amplification from these tubes. This does not mean that a tremendous amplification cannot be built up; it is quite practical to obtain an amplification of 30 or 40 per stage compared to 5 or 6 for ordinary three-element R.F. tubes.

Variable-Mu Tubes

The individual problems of coil design for this new tube are very similar to those for the '24 screen-grid tubes. The main differences in the characteristics of the two types are that the modulation distortion and cross-talk factors have been reduced considerably in the newer tubes. As these two factors indirectly affect the coil design, we shall consider them briefly.

Modulation distortion is caused by the non-linear character of some tubes. Because of this non-uniformity of frequency amplification, an increase in modulation is found at certain frequencies. This distortion is most evident when the incoming signal is a powerful one, as in the last R.F. tube. Fig. 6 shows the maximum value of the input voltage that can be employed without allowing the modulation to exceed 20% (a satisfactory value). This chart shows that the maximum voltage that can be applied to the '24 tube cannot exceed 0.4-volt while the variable-mu tube can carry a voltage of 10 without introducing any more distortion.

So much for modulation distortion. We have already mentioned cross-talk as a serious handicap in aerial coil design. Because of the inherent characteristics of the variable-mu tubes, however, this factor has been reduced several hundred times and this, combined with the ability to handle powerful input voltages, improves amplifier design tremendously.

The coils for variable-mu interstage coupling are practically the same as for the screen-grid tube. However, with careful shielding between stages, more amplification per stage can be realized than with the '24 type. By increasing the size of the first primary L1 in the coil described above and placing the second primary L2 closer to the secondary, an increase in the coupling can be obtained and, by carefully adjusting the balance, the amplification can be kept even.

Although the following description is somewhat apart from the subject of this article, the writer has decided that it will be of assistance to those who try to use these tubes. The variable-mu tube can be placed in almost any R.F. amplifier designed for '24 tubes, with better tone quality and less cross-talk. However, to obtain the greatest value from these tubes, several circuit changes are suggested. The volume should be controlled by varying the control-grid voltage instead of the screen-grid potential as advocated for the '24 tubes. The maximum amplification is achieved with a negative bias of 3 volts on the control-grid and the minimum with -50 volts.

To obtain this high grid bias, the power supply circuit must be changed somewhat. Fig. 7 shows the necessary changes to obtain the variable potential. A 3500-ohm (approximate) resistor is connected at point X of the circuit to introduce a voltage of 50 between the voltage divider and the grounded circuit. Then a potentiometer of 20,000 ohms connected between the 50-volt and the 3-volt points, A and B, respectively, will permit a variation of 3 to 50 volts. The center arm of this potentiometer is connected to the grid return.

R.F. Pentode

Because of the greater mutual conductance of the tube, higher amplification can be obtained than is possible with the '24 tube. However, the grid-plate capacity of this new tube is larger than that of the latter tube and this necessitates much care in shielding the individual stages, as well as isolating each grid and plate from those of other tubes by the use of chokes, condensers, and resistances.

(*Continued on page 570*)

AN AUTO RADIO

(*Continued from page 556*)

One 15,000-ohm carbon resistor, R2 (½-watt);
One 1500-ohm carbon resistor, R3 (½-watt);
One 200-ohm carbon resistor, R4 (1/10-watt);
Two 600-ohm carbon resistors, R5, R6 (1/10-watt);
One 25,000-ohm carbon resistor, R7 (1/10-watt);
Two 400,000-ohm carbon resistors, R8, R9 (1/10-watt);
One 2000-ohm carbon resistor, R10 (1/10-watt);
One 3000-ohm carbon resistor, R11 (1/10-watt);
One 1300-ohm carbon resistor, R12 (½-watt);
One triple-gang condenser to match secondaries of L1, L2 and L3: C1, C2, C3, (with compensators);
Eight .1-mf. condensers, 200-volt rating (D.C.) non-inductive, C4, C5, C6, C7, C8, C9, C10, C11;
One .001-mf. mica condenser, C12;
One .02-mf. mica or 300-volt rating, C13;
Four .5-mf. 200-volt, C14, C15, C16, C18;
One .002-mf. mica condenser, C17.

R. F. COIL DESIGN

(*Continued from page 569*)

The problem of coil design is one of balancing the characteristics of the primary circuit in the same manner as that described for the variable-mu tube, above.

While this description of R.F. primary-coil design has been somewhat sketchy in places, the subject makes it necessary to cover a large number of facts and it is hoped that sufficient detail has been given to the important points.


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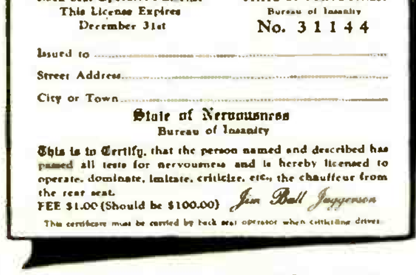
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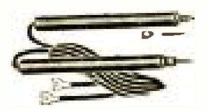

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Flechtheim superior built instruments have well earned a reputation of reliability for their unusual life and accuracy in actual use. These voltmeters which are available in two types, namely, 0 to 500 volts DC and 0-600 volts AC-DC, and which have an internal resistance of 60 ohms per volt are sturdily and attractively constructed in a nickel-plated, highly polished protective shield case. The scales are evenly and accurately calibrated so that although the range is higher than 500 volts, the comparatively low voltage of 5 can be easily and quite accurately recorded. Each meter is of the portable type, being provided with convenient mounting rings for hanging on walls or test panels. Sold complete with 3 ft. flexible test leads provided with phosphor bronze, non-corroding test tips and non-breakable color-coded insulated handles. Shipping weight—¼ lb. **List Price, $7.50.**

No. SP9051—0-500 DC Voltmeter.
No. SP9052—0-600 AC-DC Voltmeter—Your Price $3.25

★WEBSTER "250" POWER AUDITORIUM AMPLIFIER

Contains 2 Stages Super Power A.F. Amplification.

NOW $18.00 Less Tubes

ONE OF THE MOST POWERFUL SUPER POWER AMPLIFIERS EVER MADE. Ideal for theatres seating approximately 3,000 people, dance halls, schools, lectures, hospitals, auditoriums, outdoor gatherings, etc., etc. The gigantic power is at all times within control—for that matter it can be used in any home, as the volume can be regulated down to a whisper! But most important of all, the **QUALITY OF REPRODUCTION IS AS NEAR PERFECT AND LIFE-LIKE AS POSSIBLE! ITS POSSIBILITIES CAN BE SUMMED UP IN THREE WORD: ABSOLUTELY DISTORTIONLESS VOLUME!** The full benefit of the 450 volts produced is obtained.

This famous amplifier is provided with a high quality input transformer for working from a phonograph pick-up or single or double button microphone.

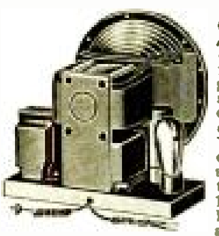
The tubes required are 1 '26, 1 '50 and 1 '81 rectifier. Where the maximum output is not required a '10 may be substituted for the '50 in the output. Automatic adjustment takes care of the discrepancy in voltages.

The undistorted power output is 2.5 watts—**ENOUGH FOR FOUR DYNAMIC REPRODUCERS.** This degree of power output provides satisfactory coverage for auditoriums having volume of 25,000 cubic feet when used with a dynamic speaker having a flat baffle board. 50,000 cubic feet when used with a speaker having a directional baffle or horn.

Over-all dimensions are 15" long by 10" wide by 6½" deep. Shipping weight—34 lbs. **List Price, $45.00.**

No. SP9059—Webster "250" Power Amplifier. Your Price... $18.00

★RCA VICTOR 11-INCH DYNAMIC SPEAKER



For 110-20 Volts 60 Cycle Operation

A superior, heavy duty unit embodying all the fine principles of construction and operation typical of all RCA and Victor radio equipment. Designed especially to accommodate large theatres, halls, armories and outdoor stadiums. Includes a completely shielded, heavy duty power transformer feeding a type 280 full wave rectifier which energizes the field coil with smooth, unfailing current. In addition this current is thoroughly filtered by an 8 mfd. electrolytic condenser which completely reduces hum to an absolute minimum. A special high quality output transformer, to operate out of any standard arrangement of power tubes, is furnished with each unit (specify the type of power tube or tubes employed when ordering). Both speaker and electric cords and plugs are supplied with speaker as is the '80 rectifying tube.

The over-all dimensions are 12" high, 12" wide and 8" deep. Provided with adequate mounting facilities.

A 9" corrugated cone insures strength and durability under the most powerful operating conditions. Capable of handling a tremendous amount of volume without distortion. Designed for 110-20 volts 50-60 cycles. Shipping weight—32 lbs. **List Price. $25.00.**

No. SP9056—RCA Victor Dynamic Speaker, Your Price.... $13.50

FREE 76 Page Radio Treatise No. 24

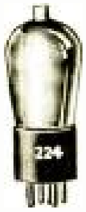
100 New Hook-Ups, etc.
675 Illustrations.

The new Winter edition of our RADIO SERVICE TREATISE, twice as large as our former one, has just come off the press. It is positively the greatest book in print—NOT JUST A CATALOG. It contains a large editorial section—a veritable book in itself—with valuable information **NOT FOUND ANYWHERE ELSE.** Among the wealth of new technical information listed in the editorial sections are the following: 1932 Complete Radiotron Characteristics **SHORT-WAVE TUNERS** and **PHONO-PICKUPS.**—Constructional Data of **SERVICEMEN'S TEST OSCILLATOR—ALL ABOUT TONE CONTROLS—SHORT-WAVE ADAPTERS AND CONVERTERS—CONSTRUCTING A 3-TUBE SUPER-HET SHORT-WAVE CONVERTER.—MODERNIZING OLD RADIO SETS.—LATEST TYPE MULTI-MU AND PENTODE TUBES.—ALL ABOUT DC RECEIVERS.—VACUUM TUBES TREATISE.**—And dozens of new radio experiments, hints to Servicemen, valuable tables of useful data, etc., etc.

This book is not just another catalog but a veritable mint of radio information which will be of infinite and everlasting value to you.

WRITE TODAY. Enclose 2 cents for postage. Treatise sent by return mail.

6 MONTHS GUARANTEED NEONTRON TUBES



Sold on a **6 MONTHS FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS!** All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLUME business!

Choice	Choice of	Choice	Choice	NEW Choice	NEW Choice
226	112A	245	222	230	235
227	200A 199X	280	210	231	247
171A	199UV-120	171	250	232	238
201A	224		281		236-37
					551
60c ea.	69c ea.	70c ea.	1.58 ea.	1.08 ea.	1.08 ea.

R.C.A. LICENSED TRIAD AND PERRYMAN TUBES

These nationally advertised tubes are guaranteed UNCONDITIONALLY for six months. The prices are slightly higher than our NEONTRONS because these tubes are of much better quality. See listing above for tube numbers.

Choice Price	Choice Price	Choice Price	Choice Price	Choice Price	Choice Price
63c	80c	75c	$1.76	$1.15	$1.15

★JEFFERSON POWERPACK—CHOKE UNIT

For '26, '27, '71A and '80 Tubes.

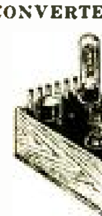
This unit consists of a standard Jefferson Power transformer and a 30 henry 500 ohm filter choke. Both are mounted in a sturdy, compact, metal case, equipped with convenient terminal strips and mounting flanges. **JUST THE THING TO CONVERT OLD TYPE BATTERY SETS INTO MODERN ALL-ELECTRIC AC RECEIVERS.** The power transformer will safely handle 5-226's, 2-227's, 2-171A's and an '80 rectifier. The filter choke is of standard design and has sufficient DC resistance to cut down the high voltage to the requisite 180 volts for the plates of the 171A power tubes. The only additional parts necessary to construct a complete power pack for AC receivers, power amplifiers or public address systems are a filter condenser bank and a voltage divider. These latter units can be furnished upon request.

Complete instruction for hooking up and wiring is supplied with each unit. Shipping weight 10 lbs. **List Price, $10.00.**

No. SP9053—Jefferson Power Pack Choke Unit. Your Price........ $2.75

World-Wide Short-Wave Set

NOT A CONVERTER



NEW

A perfect radio short-wave receiver for use between 18 and 200 meters. To put into operation, connect antenna, ground, 15 volt "B" and two No. 6 dry cell "A" batteries, and headphones to the posts provided, plug in a type '30 tube, and tune in! An ingenious circuit makes possible a 4-coil single-winding plug-in design. This little instrument has the same sensitivity as many big, shielded short wave receivers costing ten times as much. A power amplifier may be added for any degree of volume. Complete with 4 plug-in coils. Has fine vernier dial for precision tuning. **Never has a first class short-wave set sold for so little money.** This short-wave set measures 5¼x7x1 in. high, over all. Ship. weight, 3 lbs. List price, $12.50.

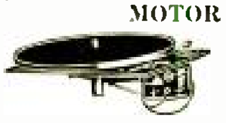
No. 1666—World-Wide S.-W. Set. Your price.................... $6.25

★MICROPHONE PRE-AMPLIFIER

An extremely compact and efficient unit designed to "boost" the weak microphone currents to proportions which will correctly match the input stages of all type amplifiers. May be used with either one or two-button microphones. This pre-amplifier unit provides a "booster" circuit with transformer, variable volume control and battery receptacle and switch, all contained in a neat metal-shielded case beautifully stuccoed in black enamel and with polished aluminum face. The case measures 6½x7¾x4¼" deep and is provided with soft rubber feet. Sold complete with 1½ volt microphone battery. Shipping weight—10 lbs. **List Price. $15.50.**

No. SP9057—Microphone Pre-Amplifier. Your Price $7.50

★6-VOLT BATTERY PHONO-MOTOR

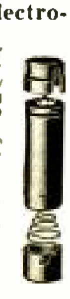


At last a **REAL** battery motor—designed especially to meet the needs of semi-portable and portable address systems especially installations on moving vehicles. It will easily and economically operate from 6 volt storage battery or the equivalent in dry cells. Draws very little current. The entire meter is flexibly pivoted upon a cast metal frame and is held taut at all times by a compensating spring, thus assuring positive contact of the friction drive gear against the inside rim of the turntable.

This arrangement was designed to overcome the effects of bumps and jars experienced by moving vehicles. The motor is sold complete with 10 ft. turntable, mounting plate and motor switch and speed control. Shipping weight—10 lbs. **List Price, $15 00.**

No SP956—6 Volt Battery Phono-Motor. Your Price............. $2.50

★Guaranteed 8-Mfd. Electrolytic Condensers



Judiciously used in many parts of any R F or A F circuits, in power packs, in dynamic speakers, they **will perform miracles in eliminating any trace of objectionable A.C. hum** or other incidental disturbances. These electrolytic condensers are particularly recommended for 250 power packs. Where the working voltage of the unfiltered A.C. is 800 volts, two electrolytic condensers in series will stand up indefinitely.

Easily mounted through the use of a bayonet socket base which is equipped with a "positive contact" spring. Totally shielded and protected by a copper cap. Shipping weight—1 lb. **List Price, $2.50.**

No. SP9054—Guaranteed 8 Mfd. Electrolytic Condenser. Your Price.... $.49

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If C. O. D. shipment is desired, please remit 20% remittance, which must accompany all orders.

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Plugless Short-Wave Converters
Power-Driven Speaker
Radio Kinks
Radio Piano
Two-Tube Short-Wave Receiver
Variable-Mu R. F. Pentode

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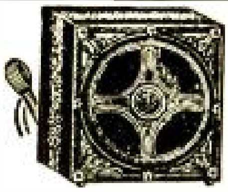
As always, there are too many of these to list at length; articles on wood turning and woodworking; model making; sheet metal work; scientific and chemical experiments; convenient and profitable hints for house decoration and furnishing; radio, etc.

$100,000 Speaker Sale!

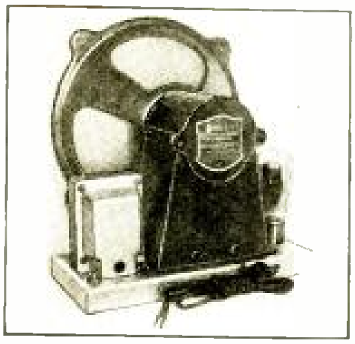
Included in this tremendous speaker sale are the products manufactured by leading speaker makers. Every speaker is brand new and shipped in original factory sealed cartons. They are sold far below their regular list price because they were bought in exceedingly large quantities and our purchase price permits us to give you the benefit of low cost.



DUO MAGNETIC

Duo Magnetic Speaker **$3.95**
Duo Inductor Dynamic Chassis **$3.95**
Similar to Farrand Inductor.

JENSEN

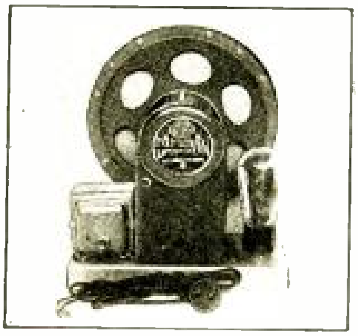


A.C.—D.8 Dry Rectfier **$14.95**
A.C.—D.7 Jr. Audit Tube Rect. **$12.95**
A.C.—D.15 Concert Jr. Tube Rect. **$8.50**
D.9—2500 OHM D.C. Field **$7.50**
D.7—2500 OHM D.C. Field **$8.50**
D.15—Midget Concert Jr. 2500 OHMS **$4.75**

MAGNETIC SPEAKERS IN BOSCH CABINETS

Due to the many battery operated sets still in use which require magnetic speakers, we offer the following in the beautiful Bosch cabinet.
B. B. L. **$4.50**
Bosch **$4.95**
R. C. A. **$4.95**
Farrand **$4.50**

BALDWIN



A. C. using 280 Tube Rect. **$7.50**
D. C. 2500 O H M—110 Volts **$5.50**
D. C. 2500 O H M—110 Volts Field Less Stand **$4.00**
D. C. 2500 O H M—110 Volts Field Less Output Trans. **$3.25**

ROLA

A. C. Models
Model 0-90-C A.C. using 280 Rect. **$9.95**
Model K. Midget A.C. using 280 Rect. **$8.50**
D. C. Models
2500 ohm P.P. Output Trans.
1000 ohm P.P. Output Trans.
2500 ohm Single Pentode.
2500 ohm Push Pull 238.
1000 ohm Single 238.
1800 ohm Single Pentode 300 ohm Tap for Bias.
$4.25 Each Model

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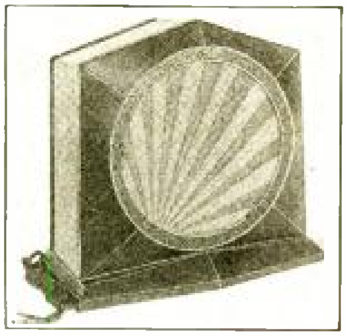
All offers are F.O.B. New York, and subject to prior sale. Terms: A deposit of 20% is required with every order. Balance may be paid on delivery. Or, deduct 2% if full amount is sent with order.



R. C. A. 100 B

Famous R.C.A. 100B Magnetic Speaker sold first time at this cut price.

$4.50

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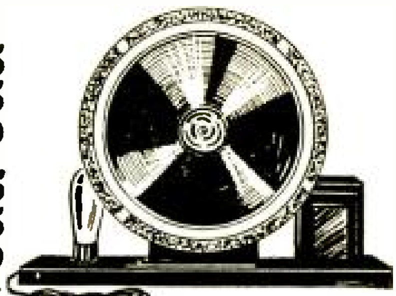

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14" Audit using 280 Rect **$12.95**
12" Concert Dynamic 280 Rect **$8.95**
9" Midget Dynamic 280 Rect **$7.50**
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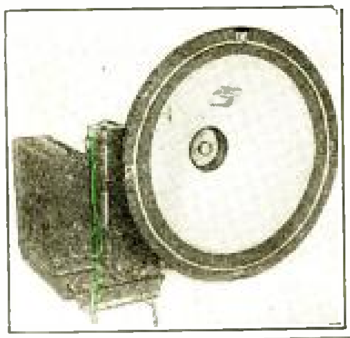
14" 5000 OHM Field **$8.95**
11" 2500 OHM Field **$4.95**
9" 2500 OHM Field **$3.49**
All 9" Midgets are supplied with Hum balancer



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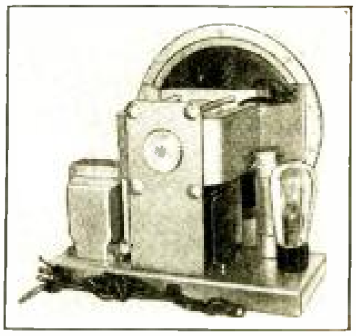
A.C. Models
12" A.C. Using Kodel Double Rect. and 2000 Mfd. Cond. **$12.95**
12" A.C. using 280 Tube **$12.50**
D.C. Model
12" 1000 OHM Field 110 Volt D.C. Line **$6.95**

R.C.A. & VICTOR



Victor A.C. Audit Model with Tube **$12.25**
Victor D.C. Audit 2500 Ohm **$8.95**
Victor D.C. Audit 2500 Ohms Less output **$7.95**
R. C. A. A.C. With tube rect **$12.50**
D.C. 8000 ohm 300 V. Field **$5.50**
D.C. 8000 ohm 300 V. Field output **$4.50**
D.C. 800 ohm 110 V. Field 12 .... **$7.50**

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Used on A.C., D.C., and Battery Sets with Equal Results.
9" Model **$5.95**
12" Model **6.95**

PENTODE ADAPTER

This Pentode Adapter permits the insertion of a type 247 Pentode Power Tube in place of the type 245 tube. Simply remove 245 tube, and insert the Adapter, and plug in the 247.
OUR NET PRICE **$1.20**

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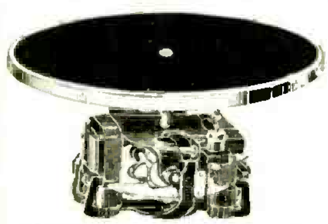
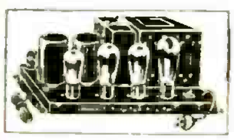
GENERAL ELECTRIC Phonograph Induction Motor With 12 Inch Turntable

Designed to meet the demand for a reliable, noiseless and non-interfering electrically operated turntable for phonographs and radio-phonograph combinations. Has double phase, compound wound induction coils and disc type balanced armature, assuring quiet, smooth operation. Governor controlled by lever and friction disc, setting of which applies proper torque for R. P. M. Constructed of the finest of electrical and mechanical parts. Equipped with 12 inch turntable. For 110 Volt, A.C.



OUR PRICE **$7.50**

KOLSTER 245 Push Pull POWER AMPLIFIER and SPEAKER

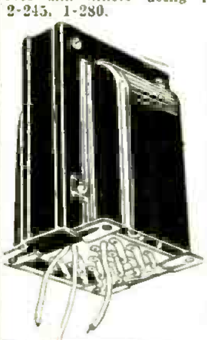


can be used with any tuner—for 110-115 volt 60 cycle A. C. The amplifier has two stages using the 227 in the first and two 245 tubes in the push pull stage, with a 280 rectifier. Kolster D. C. Dynamic Speaker to match, $4.95 extra. D. C. Field Resistance 2000 Ohms containing output transformer. Sold separately, without speaker, if desired.

LESS TUBES **$13.95**

Genuine PHILCO Power Transformers

Philco Part No. 3516, for Philco Models 65, 76, 77, 77A and others using following Tubes: 3-224, 1-227, 2-245, 1-280.



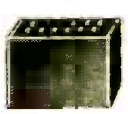
An excellent replacement transformer for most standard sets. Green and black wires, 125 V. Yellow wire C.T. of 7 and 9. Secondary connections shown on diagram.

Size: 3¾ in. long, 3¼ in. wide, 5½ in. high.

1 and 2—5 V. (280); 3—C.T. of High; 4 and 5—High V.; 6 and 10—2½ V. (245); 8—C.T. of 6 and 10; 7 and 9—2½ (227).

OUR PRICE **$3.15**

Condenser Block for Majestic "B" Eliminator



Replacement for defective blocks in "B" Eliminators — identical in electrical characteristics and outside dimensions. Can also be used in any make "B" Eliminator as well as most power packs

OUR PRICE **$2.10**

Kolster K-6 Speaker

Magnetic type cone speaker. Remarkable tone quality; volume to spare. Beautifully carved, fine Walnut cabinet. Equipped with highly sensitive oversize magnet and driving unit. Faithful reproduction from the faintest whisper to fullest volume of a brass band.

List $20.00

OUR PRICE **$3.35**

R. C. A. Loudspeaker 103

A beautiful speaker, superb in its faithful reproduction. Molded frame and pedestal resemble hand carved oak. Mechanism concealed by attractive tapestry.

(Genuine R.C.A.)

List $18.00

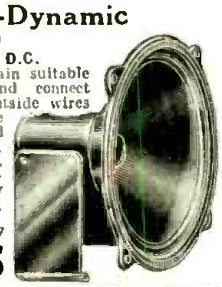
OUR PRICE **$3.43**

JENSEN SPEAKER Electro-Dynamic

(Model D7DC)

10 in. "Concert" D.C.

These hum-free units contain suitable push-pull transformers and connect directly to the set—no outside wires 2500 ohm field. 8 ohm voice coil. As most standard A.C. sets are built for D.C. speakers of this ohmage, the possibilities for replacement with this really good speaker are unlimited.



Act quickly. Quantity limited.

OUR PRICE **$8.95**

Fixed Pigtail Resistors

OHMS

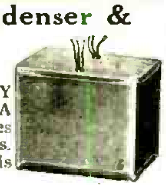
500	10,000	75,000
1,000	15,000	100,000
1,500	20,000	125,000
1,800	25,000	150,000
4,000	30,000	250,000
4,700	40,000	1 Megohm
5,000	60,000	2 Megohms

OUR PRICE **45c** PER DOZ.

Atwater-Kent Condenser & Filter Block

For Model 37 and 38 Sets

Ideal filtering system for ANY make A. C. set using 171-A tube. Contains proper chokes and high voltage condensers. Flexible wire colored leads same as original.



HOOK-UP

Green wire to 280, black to R.F. plate, yellow to Power Tube plate, white to first audio bypass, white to C.T. of 226 resistance, red to detector plate. Wire from can to ground.

OUR PRICE **$2.40**

I.C.A. Test Leads—

a necessity to the dealer or serviceman. Unsurpassed for testing sets and tracing shorts, opens and other common defects. Easily attached to testing meter or electrical apparatus. **40c**

A. C. DAYTON FLEWELLING SHORT WAVE ADAPTER

A.C. AND D.C. TYPES. This remarkable complete adapter makes a Short Wave Receiver out of any set without change in wiring. Short wave reception covering 18 to 84 meters is accomplished by 3 plug-in coils with non-corrosive nickel plated prongs, which give positive contact. There is nothing else to buy. The adapter is housed in a mahogany finished cabinet. Easy tuning with slow motion, smooth, vernier dial.

Model A-C UY. For sets using UY-227 A.C. tubes as first RF Amplifier or in the detector socket.

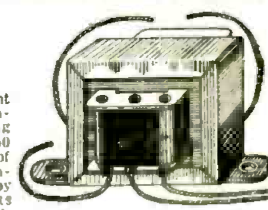
Model D-C UX. For sets using UX-201A, UX-199, WD-11, or A.C. 226 type tubes.

List Price $15

OUR PRICE FOR A.C. OR D.C. MODEL **$4.75**

T. C. A. PUSH-PULL INPUT AUDIO TRANSFORMER

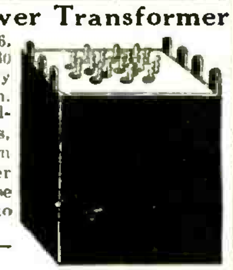
Standard replacement transformer for Push-Pull formation using 171, 245, and 250 type tubes. Core of permalloy steel laminations bound by mounting brackets which serve as shield. Dimensions: 2x2x3½ in.



OUR PRICE **90c**

Victor ABC Power Transformer

For use with 6-226, 2-245, 1-227 and 1-280 tubes. Magnetically shielded preventing hum. Can safely be overloaded 30%. High voltages, 400 volts at 150 mils on either side of center tap. Extra large case especially designed to prevent overheating.



No. 1—Center tap of 9, 14—(5 volts).
No. 2, 4—2¼ Volts.
No. 5, 7—1 in. V. High amp. (226).
No. 3, 6—Primary (110 V. input).
No. 8—Center tap of 12, 17 (2¼ V.).
No. 9, 14—5 Volts (280).
No. 10, 15—High volt B supply.
No. 16—Center tap of above.
No. 12, 17—2½ in. volts high amp. (224).

Size: 4½x5x5½ inches. Can be used for any power amplifier using 245 Tubes.

OUR PRICE **$1.95**

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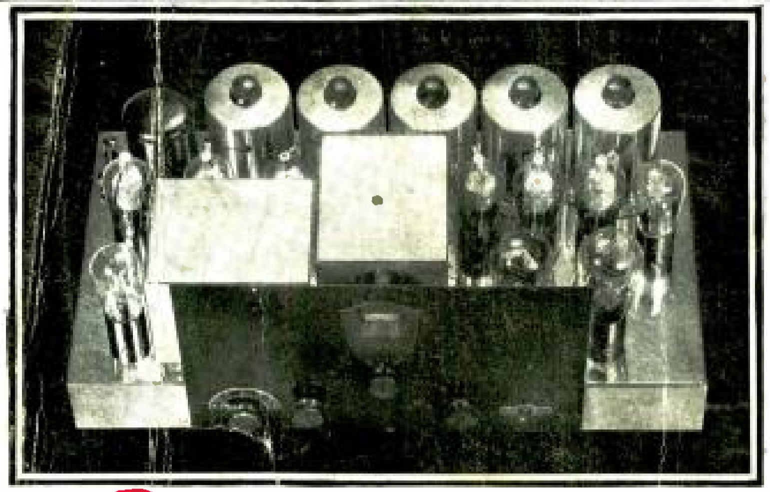
Super Power



insures

World-Wide Performance—

15 TO 550 METERS—NO PLUG-IN COILS

THE phenomenal ability of Lincoln DeLuxe receivers to receive stations from every corner of the globe is largely due to Lincoln Super-Power. The tremendous gain of Lincoln's highly efficient circuit opens a new field for the radio listener. National and international programs, fascinating foreign broadcasts, short-waves, air-mail, trans-Atlantic phone,—these and many other features are available to the Lincoln owner.

From 15 to 550 Meters at the Touch of a Switch

One of the outstanding advances in radio design of recent years is the elimination of plug-in coils for short-wave reception. Having designed the DeLuxe to tune from 15 to 550 meters, Lincoln engineers perfected an extremely efficient and ingenious design whereby a small no-capacity selector switch makes the contacts formerly made by the coil prong and socket contact. A Lincoln owner may change from broadcast to any one of four short-wave bands by merely turning the selector switch.

A New Conception of Short-Wave Reception

The application of Lincoln's mighty power to the reception of short-waves produces truly amazing results. Stations half-way around the world come in with clock like regularity. Lincoln enthusiasts in the central states have repeatedly reported *broadcast* reception of many trans-Pacific stations. The tremendous amplification of the highly engineered Lincoln circuit is always perfectly controlled in a channel less than 10 K.C. wide. A letter from Alaska reports reception of Mexico, Nebraska and Vancouver, B. C., all three stations 5 K.C. apart!

Full, Rich, Life-Like Lincoln Tone

Lincoln tone is a revelation of purity and fidelity. Lincoln experts have designed an audio system that, with either radio or phonograph pick-up input, delivers tone of astonishing richness and realism. Artificial tone compensators or control devices are not required to bring out the natural vivid tone of the living artist.

DeLuxe DC-SW-10, Battery Model, Is Extremely Efficient

The Lincoln DeLuxe DC-SW-10 is the battery model version of the famous DeLuxe SW-32 described above. Taking advantage of the new low drain 2 volt tubes, the DC-SW-10, when operated from an adequate battery source, provides exceptionally quiet, crystal clear reception of both broadcast and short-waves. This model, although intended for rural or unelectrified areas, is finding increasing favor in congested city communities because of its absolute freedom from line noise and clear life-like tone quality.

Clip and Mail NOW!

LINCOLN
DE LUXE—SW-32

LINCOLN RADIO CORPORATION

Dept. RC-3, 329 S. Wood St., CHICAGO, ILL.

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